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IN THIS ISSUE

THE COVER

THE beautiful Crescent City of New Orleans will be the setting for the 27th Annual Meeting of the National Lubricating Grease Institute. This picturesque and historic city will offer many attractions for NLGI'ers and their wives this October, including a special program for the ladies during the days (see page 260) while the various sessions and symposiums are underway in the meeting. The meeting promises to have one of the most comprehensive examinations of industry problems and the most extensive program in the history of the Institute. Story on page 259.

NLGI PRESIDENT'S PAGE

By F. E. ROSENSTIEHL, *President*

The "NLGI Spokesman"

I am sure all of us share the belief that the NLGI SPOKESMAN is an outstanding trade magazine. For the past 22 years it has been an effective voice for the grease industry, as well as a source of information for the activities of the people who make up that industry.

There are, however, numerous means by which this magazine might prove of further value and interest to the NLGI membership. For example, the editor is continually on the lookout for articles from the rank and file of the Institute's members. The magazine could provide a platform for their ideas and interests and create an exchange of information throughout the industry.

Right now a well-prepared article on Frequency of Chassis Lubrication, well-backed by authentic information, would attract readership of everyone who receives the magazine. Other subjects of current interest to our industry would likewise receive great attention.

Also, we are constantly confronted with an appreciable deficit due to the fact that the ads which the magazine carries are not sufficient to sustain the cost and publishing and distribution. Each of us should be on the alert to secure additional advertising; but in the long run it is the serious interest of the membership in the NLGI SPOKESMAN and in contributing significant articles to it that will help build it into a magazine that will attract more advertisers.

I am sure the Editor would be only too glad to have any member's comments as to how the publication could be further improved, whether it be by publication of articles of current interest, increased advertising or what not.

Let's all do our utmost to make further improvement in an already outstanding SPOKESMAN for the grease industry.

THIS IS WHAT HAPPENED WHEN

All-out motorist promotion by the Frontier Refining Company brings in new customers, dramatically increases service station traffic

▲ Greeley motorists were made vividly aware of "Moly" grease by covered wagon with provocative banners. Wagon toured streets day after day, made frequent stops at Greeley's four Frontier stations.

◀ Typical Frontier station in Greeley is operated by Robert Innis at 1028 Ninth Street. Station, in residential district off main through highways, depends on repeat business of satisfied local residents.

"MOLY" GREASE HIT GREELEY, COLO.

TYPICAL STATION MULTIPLIED GREASE SALES EIGHT TIMES; GAS SALES UP 10%

Though abnormally bad spring weather dampened sales for most service stations in Greeley, the Frontier Refining Company's outlets showed phenomenal increases. Frontier, who recently adopted *Molysulfide®* chassis grease for its service stations, had launched an all-out motorist promotion of "Moly" grease to increase service station traffic.

Results at Bob Innis' Frontier station in Greeley were typical of the response—and further proof that "Moly" grease excites the imagination and interest of both motorists and dealers. Innis reports:

> "I averaged 12 to 15 grease jobs a month before Frontier introduced 'Moly-Lith' (Frontier's brand name for its 'Moly' grease.) After putting in 'Moly-Lith', my grease sales jumped to 98 in the first 28 days. I estimate that 35 to 40% of these sales were to new customers, and I honestly believe they were attracted to my station from the 'Moly-Lith' promotion alone.
>
> "My gasoline sales increased 10% in spite of the bad weather. I can also see an increase in my sales of TBA.
>
> "Frontier 'Moly-Lith' grease has put the car on the rack, and, by my being able to get under the hood, I'm selling more fan belts, batteries, universal joints and oil filters."

TREND IS TO "MOLY" GREASE IN STATIONS

Oil marketers in growing numbers are building service station sales with "Moly" grease. The reason is simple. Its advantages are easy to demonstrate, easy to understand—*and, above all, easy for the customer to experience.* Motorists come back for it . . . ask for it . . . tell their friends to ask for it. And, as Frontier's experience shows, this increased traffic increases sales of everything the station sells.

Investigate the merchandising potential of "Moly" grease for your service stations. Climax Molybdenum Company, a Division of American Metal Climax, Inc., 500 Fifth Avenue, New York 36, N. Y.

Triple-play promotion involved coordinated effort by Frontier sales organization, advertising department and station operators. L. to R.: Dale Wright, Frontier Advertising Director; Bob Innis, local operator; Alan Gardner, Frontier's Manager of Lubricant Sales.

Special month-long promotion included big newspaper ads (in color) twice a week, 12 radio spots a day over two stations. Meetings were held with groups of truckers and farmers. Posters were supplied to stations, as were steering wheel tags to put on cars after grease job.

Write for your copy of "'Moly' Grease Brings More Business to Service Stations". This case history tells how another major oil company used "Moly" grease to promote sales.

CLIMAX MOLYBDENUM

News About NLGI

NLGI Welcomes New Member

Sefton Fibre Can company has affiliated with NLGI as an Associate member. A division of Container Corporation of America, Sefton is located in St. Louis and is a manufacturer of fibre cartridges for lubricating greases. W. V. Swofford, district sales manager, is Company Representative. A feature story on this new member firm will be presented at a future date in the NLGI SPOKESMAN.

New NLGI Booklet

The new NLGI booklet *Recommended Practices for Lubricating Passenger Car Ball Joint Front Suspensions* has proved to be an instant hit with members and friends of the Institute . . . since its introduction in the August issue of the NLGI SPOKESMAN, the Ball Joint booklet has been purchased by more than 40 companies.

Completed by a committee of members after more than two years of preparation, the twelve-page booklet is illustrated throughout with simple, easy-to-read instructions for each procedure. Offered at cost plus postage, the booklet is an economical instruction piece. Quantity discounts are offered and the back cover is blank for those firms desiring special advertising and public relations imprints.

Inquiries may be directed to the national office of the Institute, and orders will receive same-day service. NLGI's other booklet, *Recommended Practices for Lubricating Automotive Front Wheel Bearings* is also available.

Terms and Definitions

W. J. Ewbank, technical representative for Cato Oil & Grease and chairman of NLGI's Technical Committee on Terms and Definitions, has asked that all technical members who replied to his September 11 questionnaire please forward copies to him at Cato, 1808 N. E. Ninth St., Oklahoma City. The company's recent fire destroyed all NLGI Terms and Definitions material and Mr. Ewbank hopes to duplicate his records in time to present his committee's report at the Annual Meeting.

Board Meeting—Oct. 26

There will be a meeting of the Board of Directors of NLGI at noon, Monday, October 26, at the Hotel Roosevelt, in New Orleans. The following day—Tuesday, October 27, there will be a second meeting of the Institute's governing body, wherein the gavel will be passed to the new president and the new Board members will assume their responsibilities.

Annual Business Meeting

There will be a meeting of the Active member firm Company Representatives of NLGI on Monday, October 26, at the Hotel Roosevelt in New Orleans. The time and place will be posted later, for the Annual business meeting which is held for election of new officers and members of the Board.

SERVICE AIDS

Send Orders to: National Lubricating Grease Institute, 4638 Nichols Parkway, Kansas City, Mo.

WHEEL BEARING MANUAL—"Recommended Practices for Lubricating Automotive Front Wheel Bearings." More than 150,000 copies of this booklet have been distributed throughout the world. Twenty cents a copy (NLGI member price) with quantity discounts — company imprint arranged.

BONER'S BOOK—Manufacture and Application of Lubricating Greases, by C. J. Boner. This giant, 982-page book with 23 chapters dealing with every phase of lubricating greases is a must for everyone who uses, manufactures or sells grease lubricants. A great deal of practical value. $18.50, prepaid.

NLGI MOVIE — "Grease, the Magic Film," a 16-mm sound movie in color running about 25 minutes, now released. First print $300, second and subsequent orders $200 each (non members add $100 to each price bracket).

Future Meetings

OCTOBER, 1959

2-3 Association of Desk and Derrick Clubs of North America, 8th Annual Convention, Hilton Hotel, San Antonio, Tex.

11-15 ASTM Committee D-2 Meeting, Sheraton - Palace Hotel, San Francisco.

12-13 Petroleum Packaging Committee Meeting, Port Arthur, Texas

20-22 ASLE and ASME Joint Lubrication Conference, Sheraton-McAlpin Hotel, New York City.

26-28 NLGI Annual Meeting, Roosevelt Hotel, New Orleans, La.

28-30 Society of Automotive Engineers, National Fuels and Lubricants, La Salle Hotel, Chicago.

NOVEMBER, 1959

9-11 API, 39th Annual Meeting, Conrad Hilton, Palmer House and Congress Hotels, Chicago.

10-12 API, Marketing Division, Congress Hotel, Chicago.

DECEMBER, 1959

11-15 Society of Automotive Engineers, Meeting, Sheraton-Cadillac and Statler Hotels, Detroit.

JANUARY, 1960

31-Feb. 5 ASTM, Committee D-2 Meeting, Statler Hotel, Detroit.

FEBRUARY, 1960

25-26 API Division of Marketing, Lubrication Committee Meeting, Sheraton - Cadillac Hotel, Detroit.

APRIL, 1960

20-22 API Division of Production, Rocky Mountain District Meeting, Gladstone, Henning, & Townsend Hotels, Casper

MAY, 1960

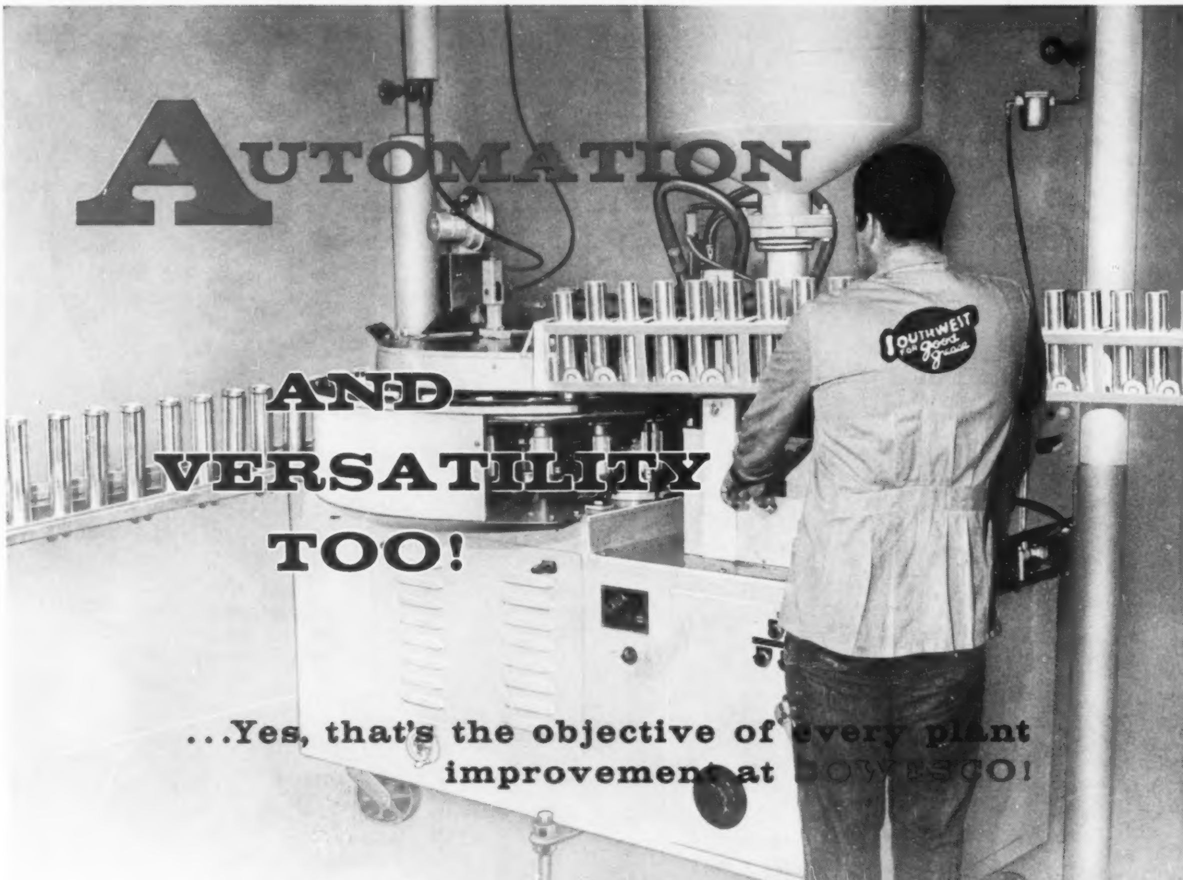
18-20 API Division of Marketing, Midyear Meeting, Statler-Hilton Hotel, Cleveland

JUNE, 1960

5-10 Society of Automotive Engineers, summer meeting, Edgewater Beach Hotel, Chicago

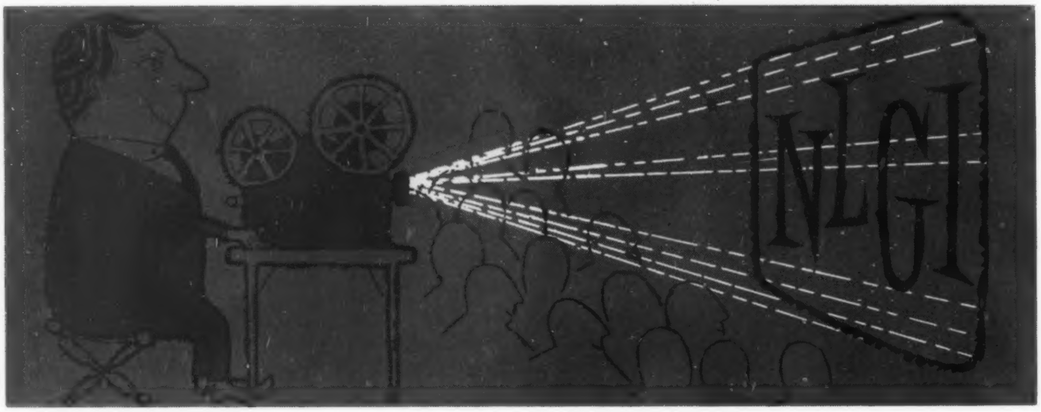
OCTOBER, 1960

31-Nov. 1 NLGI Annual Meeting, Edgewater Beach Hotel, Chicago.



AUTOMATION
AND—
VERSATILITY
TOO!
SOUTHWEST for good grease
...Yes, that's the objective of every plant improvement at SOWESCO!

two years later . . .



nlgi film doubles projected sales total

Two years after its premiere at the 25th NLGI Annual Meeting in Chicago, 1957, the Institute's movie "Grease—the Magic Film" has more than doubled the sales total projected for it at that time.

When the Institute decided to underwrite most of the cost of a short film on lubricating grease, it was felt that this picture would be an NLGI service of considerable aid to a conservative number of domestic manufacturers. The goal hopefully established was a total of 40 prints to the industry.

At this writing almost one hundred prints have been sold and distributed throughout the United States, Europe, Japan and Canada. Foreign language versions have enjoyed a good sale, but the majority of prints are English language versions. The sales gain made a price reduction possible last March.

Uses for the movie are almost without number, but many of the showings are for lubricating grease customers. Quite a few firms use "Grease—the Magic Film" as a sales training aid and almost all print owners employ the picture as a way to tell their story to the public. The 26-minute, 16 mm color movie enjoys a brisk trade with school children, too. Many showings are made from the national office prints and the youngsters learn for the first time the magic of lubrication . . . the importance of lubrication, in this modern world.

Creation of a specialized picture like this was a two-year project handled by a committee of directors. Scripts and shooting schedules, revises and improvements took time, but the end result was a film which could be adapted to a number of uses. J. W. Lane (Socony Mobil) acted as chairman of the project during 1956 and 1957. Serving with him during the two years were W. W. Albright (Standard of Indiana), A. J. Daniel (Battenfeld of Kansas City), F. R. Hart (Standard of California), F. E. Rosenstiehl (Texaco), W. H. Saunders, Jr. (International Lubricants), J. V. Starr (Esso Standard), and T. G. Roehner (Socony Mobil).

While the picture first sold for $600, the price change brought this down to $300 for the first print order and $200 for each additional print thereafter. (Non-members add $100 in each category). Preview showings for prospective purchasers are quickly made from the national offices of NLGI.

Although much of "Grease—the Magic Film" suited the purpose of Consumers Cooperative Association of Kansas City, this NLGI Active member felt the movie could be personalized to their special operation and accordingly, an eight minute section was filmed and spliced into the picture. The new footage matches the rest of the film but has personalized Co-op scenes and operations.

Initial reaction to this version has been so good that CCA is ordering another four prints for the same modification and distribution.

27th
NLGI Annual Meeting

Roosevelt Hotel
New Orleans, La.

October 25-28, 1959

The Ladies Are Invited . . .

NLGI welcomes the wives to the 27th Annual Meeting . . . a special program has been arranged to show colorful New Orleans at her best.

MONDAY MORNING

9:30 a.m.
University Street Entrance

Brunch at Brennan's, 9:45 a.m.

Walking tour of the French Quarter with special guides to describe and explain interesting points and historical background of this fabulous area.

Free period upon return to hotel.

TUESDAY MORNING

10:15 a.m.
University Street Entrance

Bus tour of Uptown New Orleans, including Garden District, Lake Shore Drive and lunch at Yacht Club, with special guides throughout the trip.

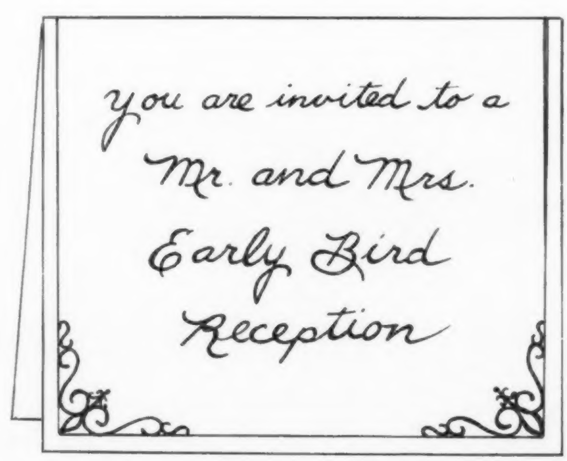
Free period upon return to hotel.

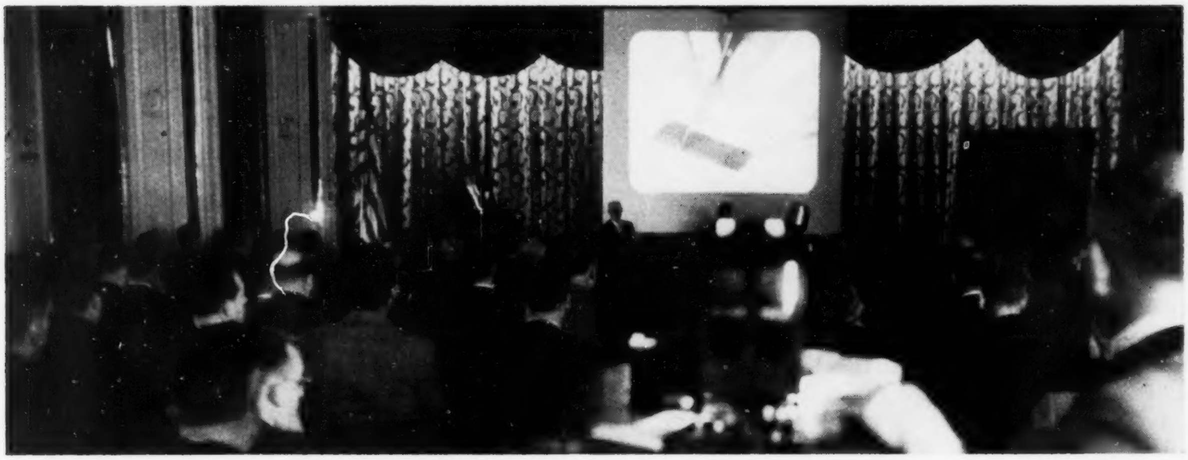
Tickets may be purchased on the Mezzanine Floor, at the NLGI Registration Desk, for $4.00 each day.

Sunday Reception for Early Birds

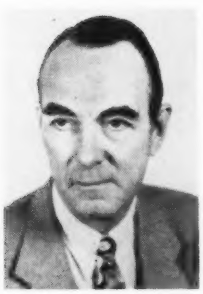
The following host companies invite you and your lady to make new friends and greet old acquaintances before the meeting starts:

American Can Company
American Flange & Manufacturing Company
Baker Castor Oil Company
Balcrank, Inc.
Bennett Industries, Inc.
Godfrey L. Cabot, Inc.
Central Can Company
Chemicolloid Laboratories
Continental Can Company
Darling and Company
Enjay Company, Inc.
Foote Mineral Company
Harchem Division, Wallace & Tiernan, Inc.
HumKo
Jones & Laughlin Steel Corporation
Lubrizol Corporation
Rheem Manufacturing Company
Stratford Engineering Corporation
Sumner Sollitt, Petroleum Industry Activities
U. S. Steel Products Division of
United States Steel Corporation
Witco Chemical Company





Tentative Schedule of Papers—1959 Annual Meeting



Robey

Economic Planning For 1960

By DR. R. ROBEY, University of South Carolina

DR. R. ROBEY, economic advisor to the National Association of Manufacturers, is a nationally known economist, editor and author.

Dr. Robey, who is professor of banking at the University of South Carolina, continues this post while serving as advisor to the NAM. He was formerly chief economist for the NAM from early 1946 to 1953.

A native of Masontown, W. Va., Dr. Robey graduated from the University of Indiana in 1920, subsequently obtaining his master's and doctor's degrees at Columbia university. He began his business career as a clerk in a New York bank and spent a short time with the Federal Reserve Board. In 1923 he became an instructor at the University of Rochester and two years later began lecturing on banking at Columbia. In 1938, Columbia appointed him assistant professor and he held that post until his resignation early in 1948.

Simultaneously with his teaching activities Dr. Robey was financial editor of the New York Evening Post from 1931 to 1933, contributing editor of the Washington Post from 1933 to 1935, and associate editor of Newsweek Magazine 1937-1938, writing the column "Business Tides" in the latter publication from 1938 to 1948.

Dr. Robey, who began doing editorial work for the NAM in 1941, is the author of several books on banking, real estate, and various economic subjects.

Roehner

Ten Years In Retrospect

By T. G. ROEHNER, Socony Mobil Oil Co., Inc.

T. G. ROEHNER, manager, technical service division, Socony Mobil, has served for twelve years as technical committee chairman for NLGI. He has seen the growth and evolution of NLGI activities, coverage, influence. He has been a part of this development and in the final year of his long service he will recapitulate industry achievement and note the highlights during the past decade.

Lane

Foell

Non-Lubricated, Non-Metallic Automotive Bearings: What—Where—When

By J. W. LANE, C. F. FOELL, Socony Mobil Oil Co., Inc.

J. W. LANE received his BS degree from Massachusetts Institute of Technology in 1931 and an MS from the same institution in 1934. Between these years he taught engineering subjects at MIT while at the same time gathering automotive experience at Franklin Motor Car company's Boston branch and at Ford's Somerville, Mass. plant. He joined the New England division of the Socony Mobil Oil Co., Inc. in 1934, subsequently becoming chief automotive engineer for that division in 1937. In 1939, Mr. Lane was transferred to Socony Mobil headquarters in New York City as staff automotive engineer. He was promoted to assistant chief automotive engineer in 1944 and then, in 1947, was appointed manager of the automotive division. In January, 1959 he was named manager of the program division of the products department, the position he now occupies. He has long been an active participant in SAE affairs, and served as chairman of the New England section in 1938. He has also devoted much time to NLGI, as a director since 1952 and serving as the Institute's 34th president, in 1957.

C. F. FOELL graduated from Syracuse university in 1926 with the degree of mechanical engineer. After a period in the power-equipment and machine-tool industries, he entered the oil business in 1929 and spent ten years in the marketing of industrial and automotive lubricants. He then did vocational educational work for the state of New York and also served five years as editor of the trade paper, *Diesel Power*. He joined Socony Mobil Oil company, Inc. in 1945 as an engineering editor and is at present a senior editor in the products department of that company.

Abstract

This paper appraises the immediate short-term impact of non-lubricated, non-metallic bearings in the automotive field. For the purposes of the discussion, such bearings are considered to be chiefly those believed suitable for passenger car suspensions, steering linkages and other applications involving oscillatory motion at comparatively low surface speeds; loads, however, may be high. The paper covers the simple fundamentals of the materials available, points out some considerations to be observed in their commercial application as an automotive bearing, and attempts to describe the results obtained in service. Current and projected applications for the 1960 and 1961 model years are explored, and inquiry is made into the possible effects on lubricating grease volume and service-station traffic over the next two or three years. The connotations of fewer opportunities for vehicle safety inspections, which have come to be an important adjunct of regular chassis lubrication service, are also weighed.

Tracy

Smith

Road Evaluation of Automotive Chassis Greases

By E. W. TRACY, JR., Southwest Research Inst.
and E. E. SMITH, Climax Molybdenum Co.

E. W. TRACY, JR. received his BS degree in petroleum engineering from the University of Texas in 1949, and his LLB degree from St. Mary's university in 1957. He is a licensed professional engineer in the state of Texas and a member of the Texas Bar. He has been with the department of engines, fuels and lubricants of Southwest Research Institute for the past seven years where he is presently senior research engineer. A specialist on automotive fuel and lubricant evaluation, he has conducted road studies totaling millions of vehicle miles. While at Southwest Research he has also worked on both turbine and piston engine evaluation and design studies of major automotive components. Previous to his employment at Southwest Research he was a consulting reservoir engineer in the Texas, Louisiana, Oklahoma and New Mexico area and was with Petroleous Mexicanos in Mexico.

E. E. SMITH is Climax Molybdenum's manager of lubricant development. He is also the company's representative to NLGI. Smith has spent most of his business life in the petroleum industry developing markets for and selling lubricants as well as other petroleum products. Smith was previously with the Cities Service Oil company, beginning as sales engineer for general petroleum products, and progressing to sales manager for petroleum waxes and sales manager for industrial lubricants in the New York area. He joined

Climax in 1955, and has been a frequent contributor to the NLGI Spokesman.

Abstract

Continued improvement and increased performance demands placed upon automotive equipment have created a need for new and improved types of chassis greases. The subsequent development of such products has in turn created the need for adequate methods of evaluating them. One such method used in a program involving over two million road miles is discussed in detail in this paper.

Very little, if any, developmental work was accomplished on chassis greases until recently. Up until this time any evaluation of the product was conducted on the basis of an experienced driver's reaction to the use of such a product in a vehicle. This paper deals with the development and conduct of a test that would produce quantitative data designed to supplement the information gained from the "experienced driver tests."

Selection of vehicle types, techniques for obtaining the required measurements and weights of wear parts, service and interim inspection periods, roads and geographical areas to be used, and use of a controlled test fleet versus a cooperative fleet are discussed.

Brunstrum

Hayne

Wear Rates in Chassis Lubrication

By L. C. BRUNSTRUM, W. L. HAYNE, JR., Standard Oil Co. (Indiana)

L. C. Brunstrum has been a member of the research department of the Standard Oil company (Indiana) since he received his BS degree in chemical engineering from Armour Institute of Technology in 1929. He is currently the section leader in charge of research on greases and industrial lubricants. He is active in ASTM and is a member of the ACS, Society of Rheology and ASLE. He is chairman of NLGI's Fundamental Research committee, after serving a number of years as vice chairman of the Institute's technical committee. In the space of a decade, Mr. Brunstrum has authored or co-authored a dozen articles for this journal. He is one of seven men to receive NLGI's "Award for Achievement," an industry award made in 1958.

W. L. Hayne, Jr. received his BS degree in chemical engineering from the University of Louisville in 1947 and an MS degree in chemical engineering at the same time. Hayne had interrupted his work at the University to serve with the U. S. Navy as an officer aboard a submarine from 1943 to 1946. He joined the research department of Standard Oil company (Indiana) in January, 1948, where he is presently employed. Mr. Hayne is a member of Sigma Tau, Theta Chi Delta, AIChE and ASLE. He has been a previous contributor to the NLGI Spokesman.

Abstract

Although road tests have been used extensively to evaluate performance of chassis greases, little quantitative information is available on wear rates. To learn how much each chassis part wears, fifteen cars representing seven makes and lubricated with four greases were drven about 25,000 miles, and wear was determined by weight loss.

The average wear rates of single bearings, in mg per 1,000 miles, were found to vary from 0.2 for steering parts to 4.0 for suspension bushings, the range for some of the parts being 100-fold. Apparently the major variable is the individual bearings, rather than kind of grease, make of car, or mode of driving. Precise comparisons of greases require testing each grease on several cars. Antiwear improvements would have to be large to be worthwhile. To avoid the difficult and costly road testing, a laboratory tester was developed that duplicates the action of plain oscillating bearings. Based on work with this tester, a grease of markedly better antiwear properties has been developed.

Ruppe

Wear Rates In Lubrication of Bus Chassis

By R. J. RUPPE, Chicago Transit Authority

R. J. Ruppe graduated from Notre Dame in 1931 with a BS degree in electrical engineering. During World War II he served with the Army Engineers. At he present time he is superintendent of shops and equipment for the Chicago Transit Authority.

Abstract

The maintenance of over 3,000 city buses which operate in all types of weather poses many problems. Wear and corrosion of the chassis must be kept to a minimum to provide good performance and prevent

equipment failures. A one year test program was set up to measure wear by micrometer measurement of the spring suspensions of eight buses in regular service in Chicago. This program was also arranged to provide information for possible improvement in lubrication practice. Two thickener types, lithium and inorganic, and an E. P. gear oil were used, and two buses were equipped with two types of centralized lubrication systems. The effect of varying the lubrication interval was also investigated. Shackle wear rates and failures were at a minimum for lubrication intervals up to 2,000 miles for the lithium greases; beyond this the wear and failure rates increased. Higher wear rates and more failures occurred with the inorganic grease at 2,500 and 3,000 miles. Oil was the poorest lubricant probably because it failed to stay in the shackles. Most of the wear occurred in the bottom shackles and most of the failures took place in the center shackles of the rear axle. A substantially better grease is required before the lubricant interval can safely be extended beyond 2,000 miles.

McCollister

More Sales — For You And Your Industry

By J. Y. McCOLLISTER, McCollister Grease & Oil Corp.

J. Y. McCollister graduated from the State university of Iowa in 1943 and saw service in the Western Pacific as radar technical officer aboard the Cruiser Birmingham. Following his release to inactive duty he was employed by International Business Machines corporation as an accounting machine salesman. In July, 1953, he resigned his position as special representative to the Meat Packing Industry to become sales manager for United Petroleum corporation. Mr. McCollister is vice-president of McCollister Grease and Oil Corp., and is president of United Petroleum corporation, a marketing subsidiary. He is a former contributor to the NLGI Spokesman and is a member of the 1959 NLGI Annual Meeting program committee.

Abstract

In recent years grease manufacturers have become concerned with developments which tend to reduce the amount of lubricating grease consumed. This paper discusses the developments and suggests a plan of action for individual companies and a plan for joint action for the grease industry.

Groszek

Bell

Retention of Liquids in Soap-Hydrocarbon Systems

By A. J. GROSZEK, G. H. BELL, British Petroleum Co.
(To be given by K. S. CUDDINGTON, British Petroleum Co.)

A. J. Groszek graduated from the University of London with a BSs degree in 1951 and an MSc degree in 1953 in physical chemistry of oils, fats and waxes. Between the years 1951 and 1953 he was employed by the Abril Corp. where he was carrying out research on synthetic emulsifying agents and waxes. In 1953 he joined the National Benzole Co., where he was a research chemist in charge of research on lubricating oils and greases. In 1957 he joined the British Petroleum Co. He is a group leader in the products research section at the Research Centre, Sunbury, working on the fundamental properties of lubricating oils and greases.

G. H. Bell graduated from the University of London with a BSc degree in 1952 and obtained the Certificate in Education from the University College of Hull in 1953. From 1953 to 1956 he served as an education officer at the Royal Air Force No. 2 radio school giving instruction in radio and radar principles. On leaving the RAF, he worked for a time as a science master at Latymers school, London, before joining the British Petroleum company in 1957. Since this time he has been working on methods of grease quality evaluation.

K. S. Cuddington graduated from the University of London with a BSc degree in 1944 and was elected an Associate of the Royal Institute of Chemistry in 1948. He joined the Research Centre of the British Petroleum company in 1944 and was seconded to the refinery in Abadan, Iran, during the period 1945 to 1947. On his return to the Research Centre, he worked in the process and product development section on catalytic and thermal reforming processes until, in 1957, he began a tour of duty as a technical representative in the New York office.

Abstract

A description is given of the measurement of the vapour pressures of the liquid phase in soap-hydrocarbon systems. A novel method using the electric discharge detector is employed for these measurements. The results are used to construct desorption

isotherms for the systems, from which information is obtained concerning the surface area of the solid phase and the proportion of liquid phase present in pores that are sufficiently small to depress the vapour pressure of the liquid.

It is considered that such information should permit an estimation of the ability of soaps to retain the liquid phase in greases at different temperatures and should give a measure of the mechanical stability of greases.

The results shown for lithium stearate and lithium hydroxy stearate systems, in the temperature range investigated (55 to 120°C), indicate that the liquid phase is bound more firmly in the latter systems at temperatures above 100°C. It is shown also that the straight chain paraffins are held much more strongly by both soaps than is a branched paraffin, and that the addition of glycerol to lithium hydroxy stearate greases causes a decrease in the surface area of the thickener.

Review of the Lubricating Grease Industry in Europe And Latin America

Sandy

By D. C. SANDY, Standard Oil Co. (New Jersey)

D. C. Sandy was graduated from Dartmouth college with an AB degree in 1934. He received an MS degree from the University of Pittsburgh in 1939. In August of 1934 he was employed by Penola, Inc. (now a subsidiary of Esso Standard Oil Co.) He entered the U. S. Navy as Lieutenant (jg) in 1942 serving with the fuels and lubricants section, Bureau of Ships, technical section U. S. Naval Attache's office, London, and the U. S. Naval technical mission for Europe. He returned to inactive duty in the Naval Reserve with the rank of Commander in June 1946. Mr. Sandy joined the refining coordination department of Jersey Standard in February of 1947.

Abstract

A survey of the available data on lubricating grease manufacturing activities in Europe and South America indicates that sufficient local supplies are available in most major countries to cover local requirements. Further, three countries in Europe ship substantial quantities into the export market. Probably for geographical reasons, no South American country appears to be an exporter. Of the European countries, only Germany imports large volumes of lubricating greases. The less industrialized South American nations continue to import a large proportion of their requirements. In Europe, since World War II, several new lubricating grease manufacturing plants have been constructed and it is believed that a number of others have been enlarged or modernized. There are reports that new grease plants have been or are being built in three South American countries. Indications are, at least in all large markets, that some of the local lubricating grease plants can supply a complete line of all types of lubricating greases. It would seem that the larger European countries will continue to supply the bulk of their needs and imports will be limited to small volume, highly specialized products. This same situation will apply in the bigger South American markets; in fact, shortage of foreign exchange may make obtaining permission to import lubricating grease into these countries very difficult.

A Modified Clay Thickener for Lubricating Fluids

Fariss

By R. E. FARISS, Baroid Div. of National Lead Co.

R. E. Fariss received a BS degree in chemical engineering at the Rice Institute in 1942. He was then employed as a research chemical engineer by the Dow Chemical Co. This was followed by a period in the Naval Reserve from 1944-1946. After release from the Navy he continued his studies at the Rice Institute and graduated in 1950 with a PhD in physical chemistry. After a short period with the Texas Co. in their Bellaire research laboratories, he joined the Baroid division of the National Lead Co. in April, 1951. His activities there have been concerned with the development of the modified clay gelling agents. In May, 1959, these responsibilities were expanded to include the technical service laboratories. Mr. Fariss is now supervisor of the Bentone and technical service laboratories for the Baroid division. He is a member of Phi Lambda Upsilon, Sigma Xi, the American Chemical Society and the American Institute of Chemical Engineers. He is a former contributor to the NLGI Spokesman.

Abstract

A new gelling agent for the preparation of lubricating greases is described. Based upon a specially processed clay and dimethyl alkyl benzyl ammonium chloride, the product is known commercially as Baragel 24. Laboratory data are given on a number of the

important variables encountered in grease manufacture. The preferred mineral oil for use with this gelling agent is described. Correlation is made between grease performance and the physical properties of the oil. The effect of dispersants and their concentration on the yield and mechanical stability of the resultant greases is discussed. Correlation is also shown between the nature of the oil and the amount of dispersant required. Procedures for preparing the greases are discussed and the relationship between process, oil and dispersant with regard to yield and mechanical stability is discussed. The effect of antioxidants, corrosion inhibitors and extreme pressure additives on the yield, mechanical stability and behavior of the greases is described. A method is given for the preparation of greases with synthetic and vegetable oils. The physical properties of these greases are given and a dispersant suggested for each system.

Hosler

Grease Containers Past, Present and Future

By W. R. HOSLER, Battenfeld Grease & Oil Corp., Inc.

W. R. Hosler has been associated with the Battenfeld Grease and Oil corporation, Inc. of Kansas City since 1940 with the exception of three years with the United States Marine Corps. He was made purchasing agent in August, 1948 and assumed the additional responsibility of becoming the company's package coordinator in June of 1950. Hosler participated in many of the pioneer ventures dealing with the lubricating grease cartridge during its introduction and has since become a recognized authority in the industry on various container developments.

Abstract

The pattern of grease packages in the early days was established by both the type lubricant available and the industrial design of equipment. Relatively few packages were required to protect and deliver the product to the consumer.

Following the early days was the branded marketing era changing the buying habits of the public and creating a variety of grease packages.

The development and acceptance of multipurpose lubricants and the effort of industry organizations have brought about some desired grease container standardizations. Many packages have been practically eliminated due to incapabilities of either manufacturing, closing, shipping, cost or acceptance by the consumer.

A new era in grease containers is just beginning! Consumers will demand economies in our present standards being satisfied by gauge reduction. Future materials for the grease packages will be papers, lighter gauge metals, plastics, and combinations of each or all. These materials fabricated into grease containers must be designed to satisfy demands for protection, economy, consumer convenience and package appeal.

Failure to recognize packages meeting these demands will result in loss of sales and recognition in the industry.

Daniels

A Study Of Open Gear Lubrication

By C. R. DANIELS, Esso Standard Oil Co. and
P. L. MALLOY, Esso Research and Engineering Co.

C. R. Daniels graduated from Carnegie Institute of Technology in 1941 with an AB degree in chemistry. He has been employed at the Pittsburgh plant of Esso Standard Old company since 1930 and is actively associated with all phases of laboratory testing control and development of lubricating greases and allied grease plant products. At the present time he is head of the Pittsburgh plant laboratory. Mr. Daniels is a member of American Chemical Society, ASTM and ASLE.

Timm

Grease Mixer Design

By K. G. TIMM, Struthers Wells Corp.

K. G. Timm is manager of the mixing equipment department and is supervising engineer in charge of general equipment division of Struthers Wells Corp. After graduating from Warren high school he completed Pennsylvania State college extension courses in

engineering, business English, and petroleum refining. He joined Struthers Wells Corp. in 1934 as a design engineer, remaining in that capacity until 1946 when he was promoted to the position of manager of the mixing equipment department, and in addition thereto during the past year has been appointed to supervising engineer in charge of general equipment division.

Abstract

Although much attention has been focused on the methods used for the production of grease, very little light has been shed on the design of the equipment responsible for such production. A review of the basic fundamentals of mixing will be presented to bring about a more comprehensive understanding of grease mixer design and a greater appreciation of grease kettle engineering. An enlightening illustrated insight into the design of a grease kettle will substantiate a number of claims already touched on through the presentation of previous papers on the subject. New designs which will influence the improved efficiency and production of the grease kettle and assist the equipment engineer in selecting the equipment best suited to his needs will be illustrated and explained. Through the eye of the motion picture camera, views of the latest developments in grease kettle design will be reviewed along with a new flow pattern which is making its debut into the field of grease mixing. The important part packaged grease plant equipment, such as hot oil heaters, plays in the overall design of the grease kettle will be touched on briefly to show the potential available to the equipment engineer.


Ehrlich


Sayles

A Philosophy of Grease Milling

By M. EHRLICH, F. S. SAYLES, American Lubricants, Inc

M. Ehrlich received his SB and SM degrees in chemistry from the Massachusetts Institute of Technology in 1933 and 1934 respectively. He worked four years as a research chemist for National Aniline & Chemical Co., Buffalo. Mr. Ehrlich taught science at Seneca Vocational high school at Buffalo four years. He has been with American Lubricants, Inc., since 1942. Mr. Ehrlich is research director and vice president. He is active in ACS, ASTM, SAE, ASLE and NLGI and has been a past contributor for the NLGI Spokesman.

F. S. Sayles received his BS degree in chemistry from Canisius college in 1943. He received his MS degree in chemistry from the same college in 1947. Mr. Sayles has been with American Lubricants, Inc., since 1943 and is now chief chemist. Mr. Sayles has contributed in the past to the NLGI Spokesman.

Abstract

Conventional grease agitators are inherently not adequate mixing devices because of the wide viscosity range of lubricating greases. During the regular processing cycle a supplemental high-shear milling device may be used which will compensate for the inadequacy of agitation. Data are presented showing that when such milling techniques are used, improved processing and product result.


Hendricks


Stoops

Material Handling and Processing Aids in the Manufacturing of Grease

By S. E. HENDRICKS, R. S. STOOPS, International Lubricant Corporation

S. E. Hendricks was graduated from "Georgia Tech" in 1934 with a BS degree in chemical engineering. He was employed as a sugar chemist for the Southcoast company his first year out of college. From 1935 to 1938 he worked for Pan Am Petroleum corp. as a tester in their laboratories. After working for Charles Martin and company as a petroleum inspector from 1938 to 1942 he was hired by International as an oil chemist. In 1944 he was appointed superintendent of the grease plant and returned to the laboratory a year later to occupy the position of chief chemist. In early 1946 he was made technical assistant to the export department and then late in 1946 he was appointed general superintendent of International Lubricant Corp., the position he now holds.

R. S. Stoops received his degree from Georgia Tech in mechanical engineering in 1941. He went to work for International Lubricants Corp. that year working in the laboratory. After less than a year he was called into the Army—his final assignment being 22 months in the Southwest Pacific area. On his return to Inter-

national in 1945 he was appointed to the new position of plant engineer with responsibility for an expansion program. So far the expansion has been almost continuous.

Abstract

Unique designs of handling and processing equipment in use at International Lubricant Corp. including a kettle vent, a low RPM kettle drive, grease strainers, handling of graphite and zinc dust, a method of closing converted open top drums and the bulk movements of grease to small packaging operations will be discussed.

The design of a kettle vent and the advantages thereof will be shown and explained.

A low RPM kettle drive and the method of obtaining the reduction of speed will be shown.

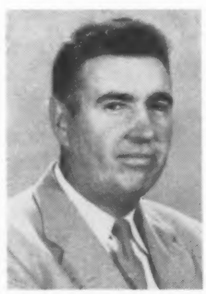
Two different designs of grease strainers and the details of the construction of each will be shown and explained.

A method of handling graphite and zinc dust used in the manufacturing of API thread lubricant to prevent "dusting" and contamination will be described.

The equipment used to facilitate the closing of 400 pound converted open head drums will be described and shown.

A method of transporting bulk grease from the manufacturing point to the small package operation involving the use of a "super drum" will be described.

Dreher



Carter

New Technique for Continuous Measurement Of Grease Consistency During Manufacture

By J. L. DREHER, C. F. CARTER, California Research Corp.

J. L. Dreher is group supervisor of the grease research and development laboratory of California Research Crop. He joined the company in 1945. Mr. Dreher obtained his AB degree in chemistry from the University of California in 1935 and began working for General Petroleum Corp. In 1943 he joined the Metallurgical laboratories (Manhattan Project), Chicago university, and was then employed by Hanford Engineering works (a subsidiary of E. I. du Pont de Nemours and Co.) in 1944. He is a member of ACS, ASLE, and American Association for the Advancement of Science. A frequent contributor to the NLGI Spokesman, he is very active in NLGI technical committee affairs.

C. F. Carter has been engaged for the past sixteen years in the development and manufacture of lubricating greases with the California Research Corporation. Mr. Carter obtained his BA degree from Polytechnic College of Engineering in 1934. In 1935 he was employed by California Research Corp., operating company of the Standard Oil Co. of California. Mr. Carter has been a keenly interested member of ASLE and is also a frequent contributor to the journal of the National Lubricating Grease Institute.

Abstract

A new laboratory grease mixer equipped with instruments for measuring torque is described. From a relationship between torque and consistency at elevated temperatures, the penetration of the finished grease can be predicted. In addition, the torque readings give an indication of the degree of mixing throughout the processing. Application of the principle to commercial equipment would greatly aid grease makers. Other notable features of this new laboratory mixer are described.

Skoglund

A Review of NLGI Tentative Dispensing Method

By R. D. SKOGLUND, Texaco Inc.

R. D. Skoglund served nineteen months in the U. S. Navy. After his military service was completed, he entered the University of West Virginia and received his B. S. degree in mechanical engineering in 1952. After graduation he was employed by Texaco Inc. and was assigned to the Texaco research center, Beacon, N. Y. His work there has included application testing with greases and industrial oils, and fuel and lubricant evaluation in various internal combustion engines. He is presently a group leader of the grease testing group in the products application department.

Abstract

An NLGI Subcommittee on delivery characteristics of dispensing equipment for lubricating greases has for many years been working on a practical test method

for determining pumpability characteristics of greases. The efforts of this committee have resulted in a test method which appears to provide a satisfactory procedure for this purpose. This paper presents a brief review of the work done by this committee, discusses the mechanics of the method and includes a copy of the actual tentative test method.

In essence, the method relates results obtained in the pressure viscometer, standard equipment in many laboratories, to actual performance data determined for a grease in a service station type air-operated dispensing system. The test method consists of three parts. In the first phase, a pump manufacturer selects a conventional automotive chassis grease and evaluates it in a special NLGI dispensing system which includes his dispensing pump. Curves are developed showing grease delivery rate as a function of apparent viscosity at 200 $sec.^{-1}$ shear rate for the grease.

In the second part, the grease manufacturer determines curves of Temperature vs. Apparent Viscosity at 200 $sec.^{-1}$ Shear Rate in the pressure viscometer for his greases of interest.

In the third part of this method, the results of Part I and Part II are combined to enable predicting what delivery rate can be expected for a grease in the dispensing system at a given temperature. Conversely the expected temperature can be determined at which a given delivery rate will be obtained.

Gabbert

Development of A Chart for Predicting the Pumpability of Greases

By W. L. GABBERT, Lincoln Engineering Co.

W. L. Gabbert, presently attached to the engineering department of the Lincoln Engineering company, was formerly on the staff of the Ranken trade school, in St. Louis, as an instructor in the electrical department. Mr. Gabbert became associated with Lincoln at approximately the time that that company became active on the dispensing committee of NLGI and has participated in Lincoln's testing program contribution to the dispensing committee's activities.

Abstract

In the interest of the refiner of lubricants, the manufacturer of lubricant dispensing pumps, and the user of both these products, attempts have been made to predict the delivery rate of the dispensers as a function of lubricant viscosity. While this has been eminently successful with oils, some difficulty has been encountered with greases, basically because of their non-Newtonian nature. This paper tells of a series of tests which seem to indicate that grease pumpability, as a function of apparent viscosity at some one shear rate, can be predicted within certain limits. Since most chassis greases fall within the working limits of the test data, the charts developed by this test are proffered as a practical criterion of pumpability of greases.

Garretson

Westinghouse Grease Dispensing Practice

By R. C. GARRETSON, Westinghouse Electric Corp.

R. C. Garretson received a BS degree in chemistry from the University of Illinois in 1939 and a BS degree in chemical engineering from the University of Michigan in 1940. He served in the army for nearly four years. From 1946-1954 Mr. Garretson worked for International Harvester Co. His duties involved standardization on use of cutting fluids and drawing compounds, and organization of a plant lubrication program. From January, 1954 to January, 1958 he was a lubrication engineer in the materials engineering dept. of the Westinghouse Electric Corp. Since then he has been the plant lubrication engineer for the East Pittsburgh division of the same company. He is a member of ASLE for which organization he was formerly chairman of the Evansville section and at present is program chairman of the Pittsburgh section. He is also a member of the Lubrication Practices committee of ASLE. Mr. Garretson is the author of several technical papers.

Abstract

A production plant the size of the East Pittsburgh division of the Westinghouse Electric corporation encounters a variety of lubricant and lubrication problems. These involve the choice and maintenance of quality of lubricants, as well as their storage, handling and dispensing. These problems are multiplied by the necessity of training, equipping and supervising a large, constantly changing crew of relatively low paid oilers.

For these reasons, and because the costs of manual lubrication are so high, the author's plant is constantly

on the alert for more efficient methods of dispensing lubricants. The use of centralized pressure lubrication systems is an obvious answer in many cases.

The use of such equipment, however, creates additional problems involving the selection of lubricants since some, which are highly desirable for particular applications, may have such poor pumpability characteristics that they cannot be used in existing distribution systems. Other difficulties encountered include pump cavitation due to poor feedability, and excessive bleeding.

Universally acceptable tests for these and other grease characteristics would enable the user to predict, based upon laboratory investigations, how a grease will act in a particular system.

Bailey

Bulk Grease Handling

By C. A. BAILEY, United States Steel Corp.

C. A. BAILEY was graduated from Ohio Northern university in 1936 with a BS degree in mechanical engineering. He was then employed with the United States Steel Corp. at Gary, Indiana as a practice engineer in the maintenance construction program of cold reduction mills and auxiliary equipment. In 1938 he received an ME degree from Ohio Northern university. In 1941 he transferred to the research department as mechancal engineer on pilot line electrolytic tinning equipment. From 1942-1945 he was lubrication engineer at the Gary Steel works. From 1945-1950 Mr. Bailey was occupied by special assignments of operating methods from the general superintendent's staff of Gary Steel works. In 1950 his assignment was to develop a lubricants testing laboratory to provide services for all of the divisions of the United States Steel Corp.

Abstract

The transition from the use of black oils in steel plants to the use of multi-purpose greases has required accompanying changes in the methods of handling the lubricants. Standardization of the 400 pound container for greases was a major step in bulk grease handling, but the containers created various problems for the industry. These problems were endured in the past due to certain concepts regarding the handling of bulk grease. Now it is thought that these concepts are outdated and that improved methods of handling grease in bulk must be developed. This paper deals with the innovations in bulk grease handling, presenting a description of the methods currently in use, as well as those under consideration.

Armstrong

Review of Research Studies Showing Need for A Viscosity Test Below 1 Sec-1

By E. L. ARMSTRONG, Socony Mobil Oil Co., Inc.

E. L. ARMSTRONG graduated from Purdue university with a BS in chemical engineering in 1940 and from Brooklyn Polytechnic Institute with an MChE degree in 1948. He was transferred into laboratory research and development work on lubricating oils and greases after an initial year of refinery experience with Socony in St. Louis. He is the author of a number of U. S. patents dealing with lubricant compositions and processing, is active in ASTM, CRC and NLGI committee work, and has been a member of fuels and lubricants panel-working groups, Department of Defense. He is a member of AIChE, ASLE, ACS, Sigma Xi, and the New York Academy of Sciences. At the present time, he is supervisor of the applied research and development section—Brooklyn laboratory in Socony's research department. He has been with Socony Mobil in the Brooklyn laboratories for nineteen years and is a vice chairman of the NLGI Fundamental Research committee.

Abstract

Studies of flow properties of lubricating greases started after Bingham and Green's work on paint in 1919. Since this time, a great deal of research has been done in many laboratories and this work is briefly reviewed. The paper is concluded with a discussion of very recent studies which show that grease flow in many long-line industrial systems occurs at very low shear rates (from about 0.05 up to about 100 sec^{-1}.) There is, therefore, a need for a suitable, standardized method to measure grease viscosity below the range of the present ASTM apparent viscosity test method. It is the opinion of the Fundamental Research Committee that NLGI should undertake the development of a grease viscosity test method for use at shear rates below 1 sec^{-1}.

Effect of Heat on 12-Hydroxystearic Acid

By: M. K. Smith
Baker Castor Oil Co.

SINCE THEIR COMMERCIAL introduction some 20 years ago, lithium base lubricating greases have accounted for a steadily increasing proportion of total grease production in the United States. It is believed that lithium base greases now comprise about 30 per cent of the total production of lubricting greases and their share of the business is still increasing. It is possible to react lithium hydroxide with a number of fatty acids to produce the lithium soap component for such greases but there is general agreement that 12-hydroxystearic acid is the preferred fatty acid.

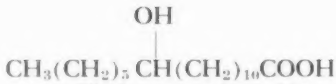
Lithium hydroxystearate can be made in-situ in the lubricating grease by reacting lithium hydroxide with 12-hydroxystearic acid (HSA), methyl hydroxystearate or hydrogenated castor oil. HSA reacts with lithium hydroxide to release water whereas the by-product from methyl hydroxystearate is methanol, both of these by-products distilling off during processing. Greases of essentially equivalent performance are obtained from either of these base materials. The grease produced by saponifying hydrogenated castor oil is generally considered slightly inferior in performance because the by-product glycerine which remains in the grease has some softening action as well as a tendency to increase water sensitivity of the grease.

In order to produce greases of optimum quality, manufacturers are tending to favor more and more the use of HSA rather than its triglyceride form. The hydroxyl group in this fatty acid, which is the source of most of its superior performance, can cause some deleterious chemical reactions which are the subject of this paper.

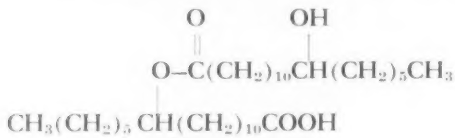
HSA is a mixture of fatty acids obtained by hydrogenating castor oil, after which the oil is saponified and split to separate these fatty acids. Starting with the generally accepted figures for the composition of castor oil fatty acids and allowing for likely changes during hydrogenation, we estimate the composition of a quality grade of HSA to be:

	Per Cent
12-Hydroxystearic Acid	88
Stearic Acid	8
Dihydroxystearic Acid	2
Unsaturated Acids	2

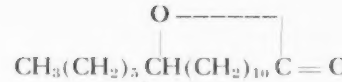
The quality of this product can be maintained only by the most careful manufacturing procedures at several stages of the process. The hydroxyl group of the starting castor oil is subject to removal (dehydration) with a corresponding increase in iodine value unless the hydrogenation is done within very narrow operating limits. Such a loss of the hydroxyl group is permanent, in contrast to the reaction to be discussed later where hydroxyl disappearance may be temporary. Castor oil is characterized by a hydroxyl value of 163-164. Theoretically, the hydrogenated oil should have a hydroxyl value of 162-163. It is impossible to hydrogenate without some reduction in hydroxyl value but a satisfactory product has a minimum hydroxyl value of 154 and a quality product has a hydroxyl value of 158. The nickel catalyst should be removed as completely as possible to avoid subsequent interference with the use of these products.



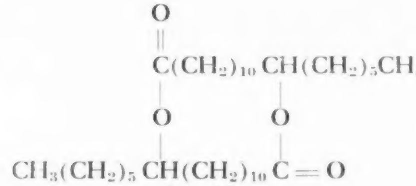
12-Hydroxystearic Acid



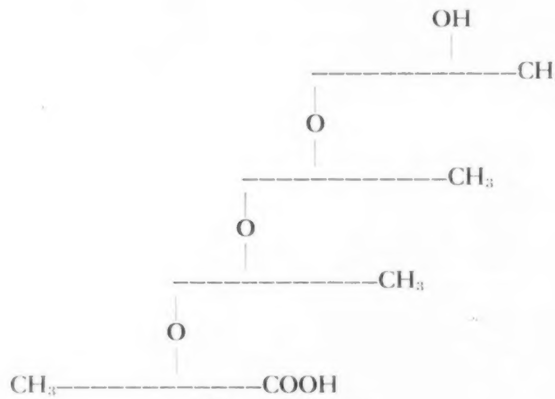
Simple Ester



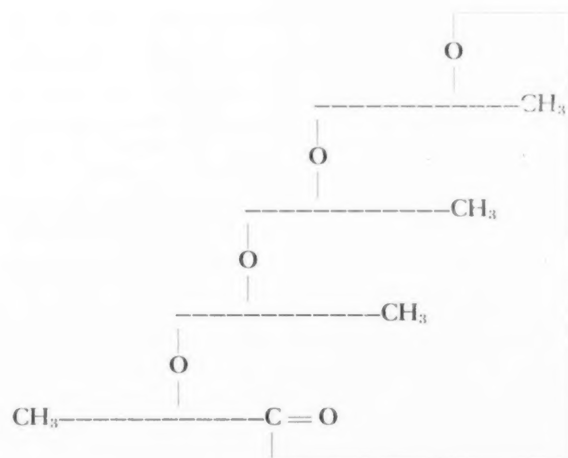
Lactone



Lactide



Linear Polyester



Cyclic Polyest.r

When the hydrogenated castor oil is saponified, its limited solubility in water forces the use of rather severe operating conditions for saponifying and splitting. Complete saponification is necessary to assure a fatty acid of maximum acid value. Hydrochloric acid is the preferred splitting agent but sulfuric acid can be used provided the reaction is done carefully to avoid sulfonation of the hydroxyl group. The washed and dried 12-HSA should have a minimum acid value of 175 and a hydroxyl value of at least 151.

The properties principally subject to change in this final processing of the HSA and which are important to its ultimate use are hydroxyl and acid values. This comes about through various self-reactions of the product, resulting in a complex mixture of products commonly called an "estolide," consisting of lactones, lactides, simple esters, linear polyesters and cyclic polyesters. The carboxyl group of the HSA reacts with a hydroxyl group to release a molecule of water, this reaction occurring in a number of ways under the influence of heat and being strongly catalyzed by acidic materials. We will discuss briefly the individual products which are formed and show below a graphical presentation of these products.

A *lactone* is formed by the reaction of the carboxyl group with the hydroxyl group of a single molecule of HSA. This product could also be called an inner-ester.

A *simple ester* is formed by the reaction of the hydroxyl group of one HSA with the carboxyl of another. This might also be considered a dimer ester.

A *lactide* is formed by the elimination of 2 molecules of water from 2 molecules of HSA. Another way of looking at it would be to consider it the further condensation of the free hydroxyl and carboxyl groups of a simple ester. Thus, it is a cyclic dimer.

A *linear polyester* is formed from the simple polyesters by continued condensation with additional HSA. The example given below shows four HSA molecules linked together in this manner. No matter how many HSA molecules are combined, the linear polyester so formed will have one free carboxyl and one free hydroxyl group.

A *cyclic polyester* is formed when the free carboxyl reacts with the free hydroxyl of the linear polyester.

Estolide formation is accompanied by a drop in the hydroxyl value of the HSA and a proportional drop in its acid value. To demonstrate this, we have made a careful laboratory study of the rate at which such changes occur in HSA held at various temperatures from 100-140 C. Included in this heat stability test were hydrogenated castor oil and methyl hydroxystearate to

demonstrate the greater heat stability of these forms of the product. The procedure used was as follows:

1. About 25 grams of melted fat were poured into a specially cleaned 50 ml beaker.
2. The beaker was sealed by covering it with an overturned aluminum dish whose edges were pressed tightly against the beaker.
3. A number of such samples of each product were placed in a standard laboratory oven capable of maintaining the desired temperature to an accuracy of $\pm$ 1°C.
4. By means of a metal rotator on each shelf and a scheduled shifting about of samples within the oven, we assured uniform exposure to temperature.
5. Samples were removed at the intervals shown below and tested for acid value and hydroxyl value.

		Methyl Hydroxystearate		12-Hydroxy-stearic Acid		Hydrogenated Caster Oil	
Held at —°C	*Hours*	*Acid Value*	*Hydroxyl Value*	*Acid Value*	*Hydroxyl Value*	*Acid Value*	*Hydroxyl Value*
100	0	4.4	164	178	153	1.9	160
	2	4.5	164	174	150	1.9	160
	4	4.5	164	169	145	1.9	160
	6	4.4	164	166	142	1.9	160
120	2	4.4	164	175	151	1.9	160
	4	4.4	164	168	143	1.9	161
	6	4.4	164	160	136	1.9	160
130	2	4.4	160	165	142	1.9	159
	4	4.6	161	156	136	1.9	159
	6	4.4	162	147	122	1.9	159
140	2	4.4	159	161	138	1.9	161
	4	4.4	160	147	123	1.9	162
	6	4.4	162	135	112	1.9	161

It is quite apparent from this investigation that the hydrogenated oil and its methyl ester are completely stable products at these temperature levels whereas the HSA drops rapidly in acid and hydroxyl values, especially at temperatures of 130°C or higher.

The chemical stability of the estolides is shown in the fact that the titration for acid value reaches an end point without opening up estolide linkages. Furthermore, ordinary saponification techniques will result in little or no increase of acid value for HSA that has been internally reacted by exposure to heat. Only severe conditions, such as treating with alcoholic potash to measure saponification value, will open the estolide structure and restore the linear HSA. Another measure of the estolide stability is that it will not open readily or completely under esterifying conditions such as heating with acid-catalyzed butyl alcohol.

We wish to note here that the same estolide formation occurs with the fatty acids of castor oil itself and in this case occurs to a substantial amount even at normal temperatures during prolonged storage. This tendency to estolide formation is so strong it makes it impossible to produce HSA by the direct hydrogenation of castor fatty acids. In connection with our manufacture and sale of castor fatty acids, we had learned over the years that the presence of estolides seriously interfered with the chemical performance of this product. It was on the basis of this knowledge, plus the fact that the hydroxyl group is the outstanding characteristic of HSA, that Baker decided to manufacture HSA only to the high standards mentioned above.

It is recognized that under special conditions, some amount of estolide might be tolerated or even desirable. For example, U. S. Patent 2,877,181 assigned to The Texas company claims that a more stable anhydrous calcium grease can be produced if the HSA used contains from 0.5 to 3 per cent of estolides. On the other hand, we know that under many conditions of reaction, the estolide structures are so firmly established that normal saponification as with lithium hydroxide would not occur. It is our belief that the superior performance of this hydroxy-containing fatty acid over other fatty acids justifies the care in manufacturing our company is taking with the product. We hope this same attitude will be taken by the grease manufacturer in his subsequent use of the product so that wherever possible, the manufacturing operation will be carried out in a manner assuring retention of the hydroxyl group.

About the Author

M. K. SMITH *received his BS degree in chemistry from the Worcester Polytechnic Institute in* 1935. *He has been associated with the Baker Castor Oil company since* 1941 *and is presently manager of their technical division. Among the ten U. S. patents issued to Mr. Smith is one on the use of Methyl Hydroxystearate to make grease. Mr. Smith is a member of ACS, AOCS, CCDA and CMRA.*

Plastometric Measurement of Flow Properties of Lubricating Greases

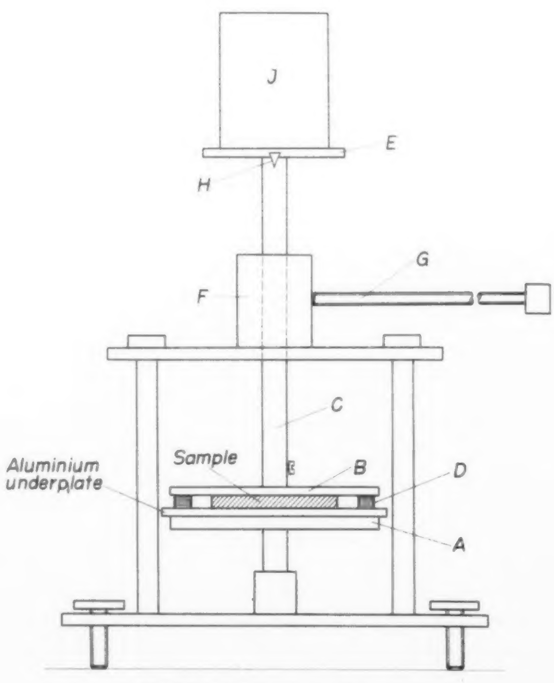


FIGURE 1, plastometer for greases

By: B. Yamaguchi

T. Oki

Tokyo University

Dr. Yamaguchi is technical adviser to Kyodo Yushi Grease Co., NLGI Active member in Japan.

Introduction

In the previous paper[1] we advanced the theory that the syneresis (oil separation) of lubricating grease is due to its creep, and devised, upon the assumption that syneresis in grease proceeds in direct proportion to creep, "syneresis index" as a measure for evaluating the initial rate of syneresis. In the present investigation, with the aim of obtaining direct evidences in support of the above assumption, we carried out plastometric measurements of the flow properties of several representative samples of lubricating greases and measurements of their syneretic behaviors, using the same experimental conditions (the same temperature, load and size and shape of test-piece) in both cases. The existence of creep phenomenon was ascertained in every sample used. This fact indicates that the flow property or the firmness of lubricating grease depends on time and must be, therefore, expressed as a function of time. Nutting[2] considered that the firmness of visco-elastic bodies can be generally expressed by the following function, ψ

$$\psi = S^{\beta}\sigma^{-1}t^{k} \qquad (1)$$

where S is the stress exerted on the test-piece of a sample, σ is the strain of the test-piece, t is the time during which the stress is exerted and β and k are constants peculiar to the sample. If equation (1) is valid for lubricating grease, i.e. if the creep behavior of lubricating grease can be represented by equation (1), the firmness of lubricating grease may be more appropriately and more reliably expressed by the value of ψ or $\log\psi$ than by the value of A.S.T.M. penetration.

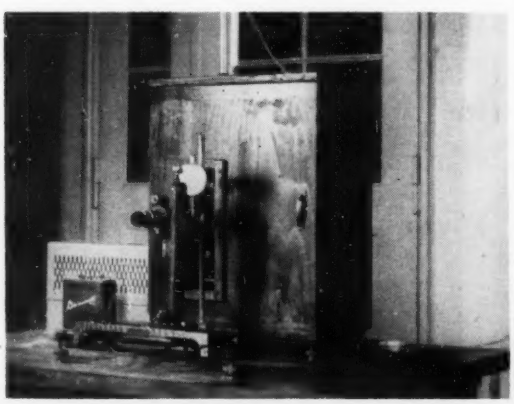


FIGURE 2, the constant temperature air bath in which the plastometer is placed

Experimental Apparatus and Procedure

The plastometer employed for measuring the flow properties of lubricating greases is shown in Figure 1. It consists of a table (A) on which a moulded disk-shaped test-piece of lubricating grease to be tested is placed together with its aluminum underplate and a compression plate (B) (5 cm in diameter) connected by the vertical rod C through the guide F to the pan E on which the weight J is loaded. By means of the screw G, the horizontal compression plate B together with the rod C can be fixed to an arbitrary height. The manipulation of the screw G can be made from the outside of the constant temperature air bath (shown in Figure 2), in which the plastometer is placed. H is a pointer, by which the vertical displacement of the compression plate is indicated. D is a pair of rest-plates having the thickness of 3.00 mm and is used in compressing the test-piece to a definite thickness (to the thickness of the rest-plates) before the testing is carried out. The inside of the constant temperature air bath in which the plastometer is placed is illuminated by a small lamp, and the vertical displacement of the pointer H during the time of testing is measured through the front glass window of the bath by means of a small-sized cathetometer with a dial gauge. Disk-shaped test-pieces prepared by moulding the samples

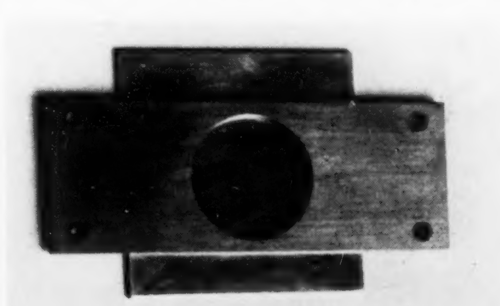


FIGURE 3, moulding plate for grease

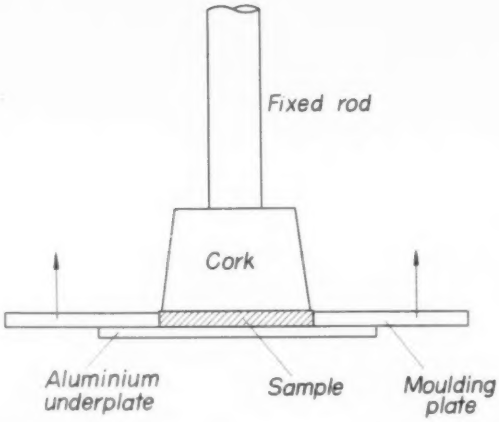


FIGURE 4, procedure for taking out the moulded testpiece

of lubricating greases were used for the plastometric measurements. The preparing method of the test-pieces is as follows: A moulding brass plate (3.02 mm in thickness) having, as shown in Figure 3, a circular hole of 30 mm in diameter is placed on an aluminum underplate previously washed by petroleum ether. Then a sample of lubricating grease is filled by a spatula into the hole to the extent that it overflows at the rim. Care must be taken in this case not to leave air bubbles in the filling. Now, using a spatula having a long straight edge, the excess grease is scraped off by moving the long edge of the spatula held by hand in contact with the surface of the moulding plate horizontally along the surface in the direction rectangular to the edge. For taking out the sample thus moulded from the hole of the moulding plate, the following procedure is taken. At first a circular aluminum foil whose diameter is a little smaller than that of the hole is placed on the upper surface of the sample moulded in the hole and further on it a cork of about the same diameter is placed. Then with the cork held softly from the upper side by means of a fixed vertical rod as shown in Figure 4, the moulding plate is removed by lifting it vertically by the hand. In this way we can obtain a moulded test-piece of the sample placed on the aluminum underplate. The above-described method of moulding is applicable for every kind of lubricating grease unless the sample is too soft (ASTM penetration > 300).

Before commencing the measurement, the moulded test-piece together with the aluminum underplate is placed in position on the table A of the plastometer, the rest-plates D are inserted on both sides of the test-piece, and the compression plate B is lowered to mount on the test-piece. Then, the compression plate is loaded with the weight J by which the test-piece is compressed to the thickness of the rest-plates and the rod C is then fixed by tightening the screw G. Now, keeping the rod C fixed, the rest-plates are removed by pushing them horizontally out, and thereafter G is loosened. As the deformation (the flow) in the test-piece commences at this moment, the change in thickness with time of the test-piece is measured by the cathetometric observation of the displacement of the pointer H.

The test-piece used for the determination of syneresis is the same in shape and size as that used for the plastometric measurement, but the test-piece is in this case moulded on a circular pre-oiled filter paper (5 cm in diameter) and also when the test-piece is taken out of the moulding plate, a circular pre-oiled filter paper is used instead of the previously described aluminum foil. The pre-oiled filter paper is prepared by wetting a filter paper before use with a light petroleum oil with subsequent removal of excess oil. The method employed for the determination of syneresis is similar in principle to the Herschel Press test.[3] In making a determination, the test-piece is sandwiched between the pre-oiled filter paper on which it is placed and another similarly pre-oiled filter paper of the same size (5 cm in diameter), and after a disk of blotting paper is placed on each side of the sandwich, the whole thing is pressed in an air bath of a constant temperature (26.5°) by the same load as that used in the plastometric measurement. After various lengths of time, the sandwich is weighed and the amount of oil separation is calculated.

Results of Experiment

a) *The relation between creep and syneresis*

In this experiment where the relation between creep

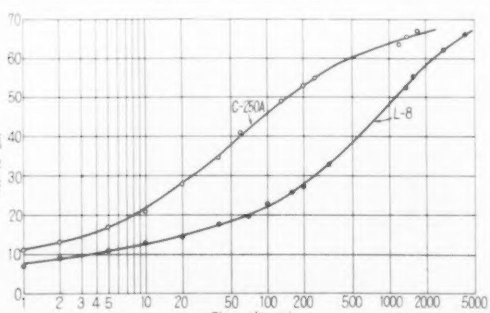


FIGURE 5, the flow curves (△*h*-log*t* curves) of the samples C-250 and L-8

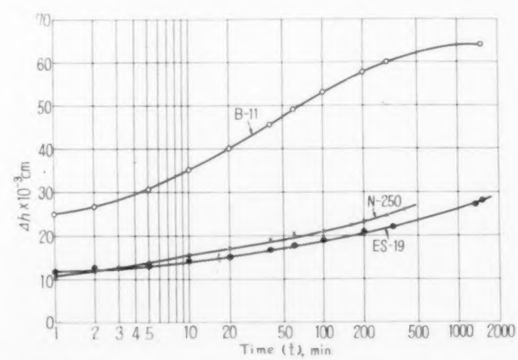


FIGURE 6, the flow curves (△*h*-log*t* curves) of the samples B-11, N-250 and ES-19

TABLE I

The Samples of Greases Used for Studying the Relation Between Creep and Syneresis

Grease	*Composition*	*ASTM Penetration*	Δh_0 (10^{-2}*mm*)
C-250A	Commercial cup grease	272	9.0
N-250	Commercial soda grease	192	12.0
L-8	Lithium grease { Lithium hydroxystearate 8.0% Turbine oil 92.0%	222	6.0
B-11	Bentone grease { Bentone 34 11.0% Mineral oil 89.0%	295	17.5
ES-16	Estersil grease { Estersil 19.0% Mobile oil 81.0%	206	11.6

and syneresis of lubricating grease was investigated, the same load (350 gms) was used both in the plastometric testing of flow property and in the testing of syneresis of each sample. The samples of grease used in this experiment are shown in Table 1. Figures 5 and 6 illustrate the flow curves of those samples determined at 26.5°C by the plastometric measurements. In these figures, Δh denotes the decrease in thickness due to compression of the test-piece at the time t in the testing, i.e. the difference between the initial thickness h_0 and the thickness h at the time t of the test-piece. As is evident from the flow curves, there occurs, in every case of the samples, an initial abrupt deformation (an abrupt decrease in thickness) of the test-piece at the moment when the test-piece is loaded and thereafter a gradual decrease in thickness due to creep of the test-piece with time. If we denote, therefore, the initial abrupt decrease in thickness of the test-piece by Δh_0 and the subsequent decrease in thickness due merely to creep of the test-piece at the time t by γ, the total decrease in thickness at the time t of it is given by

$$\Delta h = \Delta h_0 + \gamma \qquad (2).$$

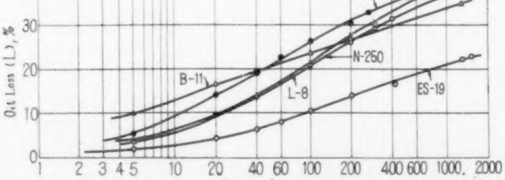


FIGURE 7, syneresis curves (*L*-log*t* curves)

The syneresis curves illustrating the relation of the oil separation with time of the samples are given in Figure 7, where L taken as the ordinate denotes the oil loss (%) due to syneresis. The syneresis curve is similar in shape, in each case of the samples, to the flow curve. If the assumption that syneresis proceeds in direct proportion to creep is true, the degree in oil loss of a sample at any time t must be proportional to the extent in creep at that time (given by γ/h_0) of the sample. Therefore $L = k_1\dfrac{\gamma}{h_0} = k_2(\Delta h - \Delta h_0)$ (3), where $k_2 = k_1/h_0 =$ a constant.

The relationship between Δh and L which we obtained with each of the samples used from the experimental values of Δh and L measured for different lengths of time is shown in Figure 8. As seen from the figure, we have, in every case of the samples, a linear relationship between Δh and L in agreement with equation (3), and this should be a direct proof of the fact that syneresis proceeds in direct proportion to creep. In the figure, the intercept of the extrapolated portion of each straight line showing the relation between Δh and L with the time axis gives the value of Δh_0 for the corresponding sample. The values of Δh_0 thus determined are shown in Table 1.

b) *Formula expressing the firmness of grease*

To express the creep behavior of a lubricating grease, the generalized equation of Voigt[4] for the creep of visco-elastic bodies might be used, as discussed in the foregoing paper, if the distribution function of retardation times of the grease were known. As it is, however, almost impossible to determine that distribution function exactly, the theoretical equation of Voigt has little practical value for expressing the flow property of lubricating grease. On the other hand, Nutting's formula (equation (1)) is practicable, if it is valid for lubricating greases, to express the flow property or the firmness of them.

The confirmation of the applicability of equation (1) for lubricating greases was made from the experimental results of the plastometric measurements carried

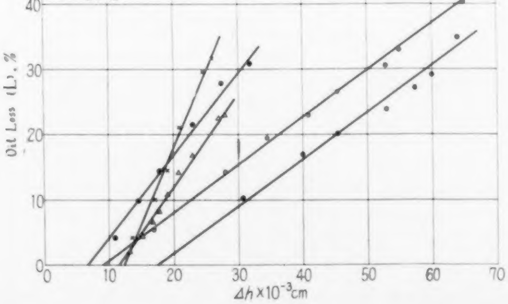


FIGURE 8, relation between creep and oil separation

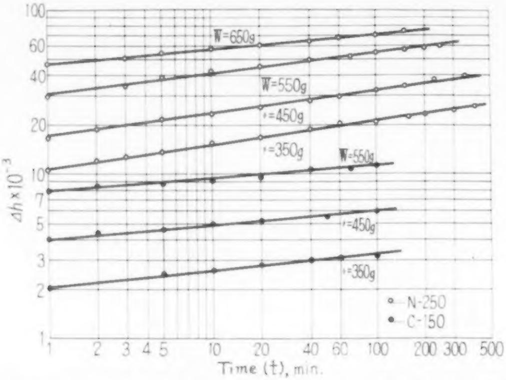


FIGURE 9, the relations between log$\triangle h$ and log$t$ for different loads of the samples N-250 and C-150

out with different loads, and the values of ψ of the samples used were determined.

To determine the value of ψ, it is necessary to obtain previously the values of β and k in equation (1) from the experimental data. As the strain at the time t of the test-piece in the plastometric compression is given by $\sigma = \Delta h / h_0$, we obtain from the equation (1) the relation

$$\Delta h = \frac{h_0}{\psi} S^{\beta} t^{k}$$

or $$\log \Delta h = \log \frac{h_0}{\psi} + \beta \log S + k \log t \qquad (4).$$

By this equation it is shown that if the stress S is constant, a linear relationship holds between logΔh and log$t$. And in this case the value of k is determined graphically from the slope of this straight line. In the case of our plastometric measurements, however, the stress S, that is equal to W/A where W is the load used and A is the surface area (the area of the one face) of the test-piece in compression, is not constant during the time of testing, because A increases with increasing compression of the test-piece. As A is thus a func-

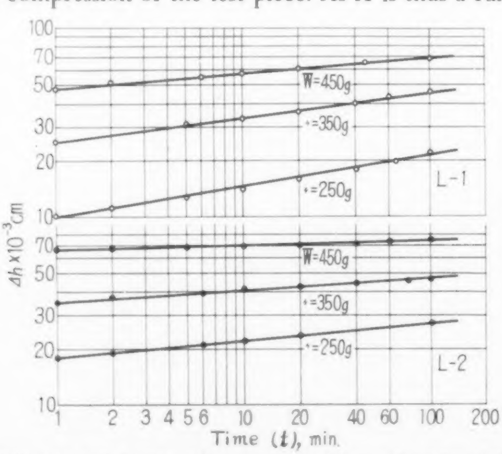


FIGURE 10, the relations between log$\triangle h$ and log$t$ for different loads of the samples L-1 and L-2

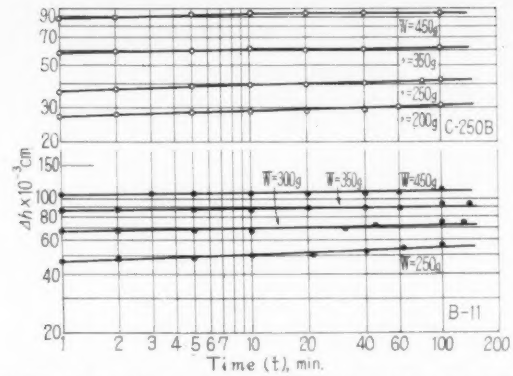


FIGURE 11, the relations between log$\triangle h$ and log$t$ for different loads of the samples C-250B and B-11

tion of t, we obtain from equation (4) the following relation,

$$\frac{d\log\Delta h}{d\log t} = k + \beta \frac{d\log S}{d\log t} = k - \beta \frac{d\log A}{d\log t} \qquad (5),$$

for $S \times A$ is equal to the load used (definite).

If it is assumed that the volume of the test-piece does not vary with compression, $A \times h = \alpha$ (where α is a constant) or $\log A = \log \alpha - \log h = \alpha' - \log h$ (where $\alpha' = \log \alpha$). Accordingly

$$\frac{d\log A}{d\log t} = -\frac{d\log h}{d\log t} = -\frac{d\log(h_0 - \Delta h)}{d\log t},$$

but as we have

$$\log(h_0 - \Delta h) = \log h_0 (1 - \Delta h / h_0)$$

$$= \log h_0 + \log(1 - \Delta h / h_0) \doteq \log h_0 - \Delta h / h_0 \quad (\because \Delta h << h_0),$$

$$\frac{d\log A}{d\log t} \doteq \frac{1}{h_0} \frac{d\Delta h}{d\log t} = \frac{\Delta h}{h_0} \frac{d\log\Delta h}{d\log t}.$$

Therefore equation (5) becomes

$$\frac{d\log\Delta h}{d\log t} = k - \beta \frac{\Delta h}{h_0} \frac{d\log\Delta h}{d\log t}.$$

Transforming the above equation and introducing equation (2) in it, we obtain

$$\frac{d\log\Delta h}{d\log t} = \frac{k}{1 + \beta \dfrac{\Delta h}{h_0}} = \frac{k}{1 + \beta \dfrac{\Delta h_0 + \gamma}{h_0}} \qquad (6).$$

For $\gamma << h_0$, that corresponds to the case when the load is suitably great,

$$\frac{d\log\Delta h}{d\log t} \doteq \frac{k}{1 + \beta \dfrac{\Delta h_0}{h_0}} \qquad (7).$$

For a definite load, the value of Δh_0 of each sample is definite and the right-hand side of equation (7) is therefore constant. Accordingly, a linear relationship between $d\log\Delta h$ and $d\log t$ must hold also in the case

TABLE II
The Flow Properties of Greases (26.5°)

Grease	Composition	ASTM penetration	k'	β	$\log\psi$	Δh_1 for W =350 gms (cm)
N-250	Commercial soda grease	192	0.166	2.74	14.4	10.6×10^{-3}
C-250B	Commercial cup grease	249	0.032	1.60	8.12	57.4×10^{-3}
C-150	Commercial cup grease	184	0.098	3.02	16.3	2.12×10^{-3}
B-11	Bentone grease {Bentone 34 11%, Mineral oil 89%}	295	0.049	1.49	7.53	86.0×10^{-3}
L-1	Lithium grease {Lithium hydroxy-stearate 8%, Mineral oil 92%}	227	0.176	2.87	14.5	25.0×10^{-3}
L-2	Lithium Grease {Lithium hydroxy-stearate 10%, Mineral oil 90%}	234	0.117	2.68	13.4	34.8×10^{-3}

of the results of our plastometric measurements. As the slope of such a straight line is given by

$$k' = \frac{d\log\Delta h}{d\log t} \doteq \frac{k}{1+\beta\dfrac{\Delta h_0}{h_0}},$$

the slope (the value of k') increases with the decrease in Δh_0 or with the decrease in weight of the load used.

The results of the plastometric measurements made with different loads of each of the samples are illustrated in Figures 9-11. From the results it is seen, in agreement with the foregoing conclusion, that a linear relationship exists approximately, in all cases, between $d\log\Delta h$ and $d\log t$ and also that the slope k' of the straight line increases with the decrease in W or with the decrease of the value of Δh_1 by which the decrease in thickness of the test-piece at the time when $t = 1$ min. is denoted. And this fact, moreover, proves that equation (1) is applicable for greases at least in the range of the testing time (t<400 min.) used for the present measurements. In Table II, the grades and compositions of the grease samples used in these experiments are given together with their values of ASTM penetration.

It is further recognized from the results that the value of Δh_1 has, in each case of the samples, a linear relation with the value of k'. For example, the linear relation found between Δh_1 and k' in the case of the sample N-250 is shown in Figure 12. It is, therefore, possible to determine $k_0 = \lim k'$ ($\Delta h \rightarrow 0$) by graphical extrapolation. The value of k_0 corresponds to the value

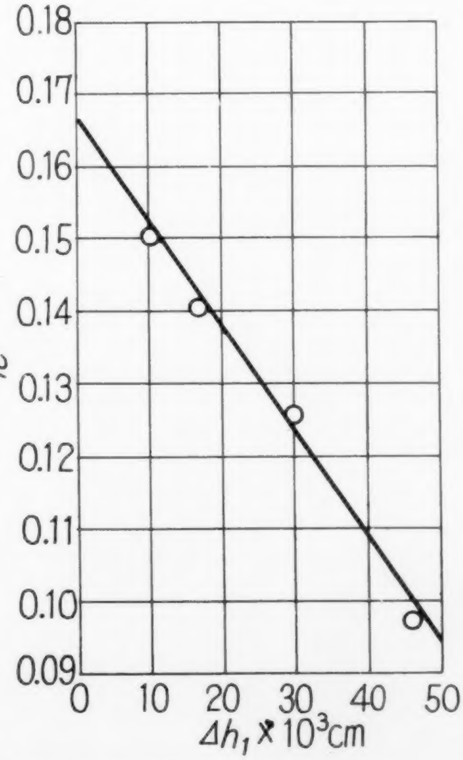


FIGURE 12, the relation between $\triangle h_1$ and k' of the sample N-250

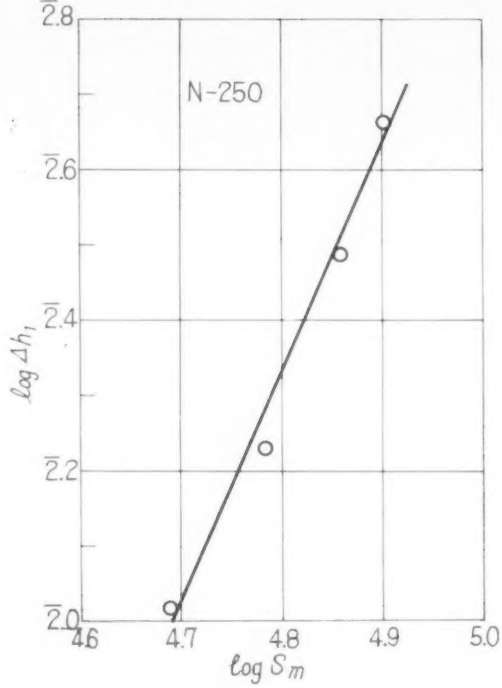


FIGURE 13, the relation between $\log S_m$ and $\log \triangle h_1$ of the sample N-250

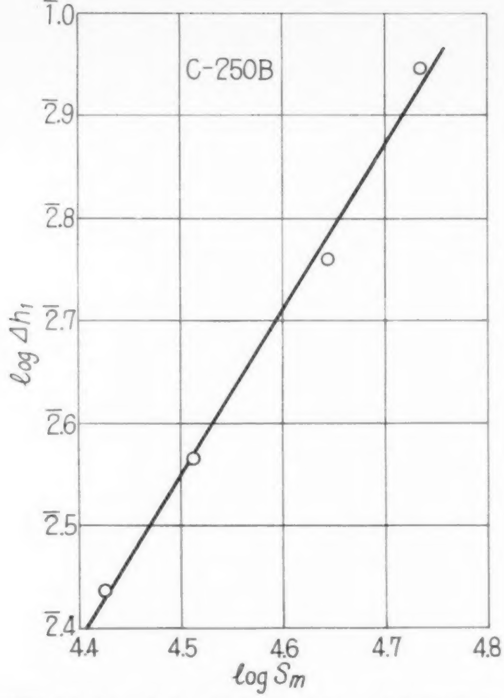


FIGURE 14, the relation between $\log S_m$ and $\log \triangle h_1$ of the sample C-250B

k' might have, if the initial stress S remained unaltered during the time of testing.

The determination of the exponent β in equation (1) is possible only in an approximate way. For this purpose the mean value of the stress during the testing time and the value of k_0 determined in the above-described manner are applied. As the value of γ, i.e. the decrease in thickness of the test-piece due merely to creep is generally very small, the stress S after the initial one minute of the testing time (after $t = 1$ min.) may be considered to remain virtually unaltered. Now if it is assumed that the stress S_m having the mean value of the stress during the initial one minute works invariably on the test-piece, the decrease in thickness Δh of the test-piece in this case, according to Equation (4), represented by

$$\log\Delta h = \log\frac{h_0}{\psi} + \beta\log S_m + k_0\log(t-1) \qquad (8).$$

But we have $k_0\log(t-1) = \log\Delta h - \log\Delta h_1$

and therefore

$$\log\Delta h_1 = \log\frac{h_0}{\psi} + \beta\log S_m.$$

Transforming the equation, we obtain

$$\log\psi = \log h_0 + \beta\log S_m - \log\Delta h_1 \qquad (9)$$

Therefore, there exists also in this case a linear relationship between $\log S_m$ and $\log\Delta h_1$, and the value of β is given by the slope of the straight line. When β is thus given, then the value of ψ or $\log\psi$ can be calculated by the equation (9).

For determining the value of S_m, it is necessary to calculate the mean area of the compressed face of the test-piece during the initial one minute of the testing time. If we denote, as in the above, the initial face area and the initial thickness of the test-piece respectively by A_0 and h_0 and denote the face area and the thickness at the time t respectively by A and h, we have

$$A_0 = A - \Delta A \text{ and } h_0 = h + \Delta h,$$

where ΔA is the increase in face-area at t and Δh is the decrease in thickness at t.

When the constant volume of the test-piece during the compression is assumed,

$$Ah = (A_0 + \Delta A)(h_0 - \Delta h) = A_0 h_0.$$

Hence $\Delta A = \frac{A_0}{h_0}\Delta h$ and $A = A_0 + \Delta A = A_0(1 + \Delta h/h_0)$.

If the load used is W (in gm), the stress S working on the test-piece at the time t is, therefore, given by

$$S = \frac{980\ W}{A_0\left(1 + \frac{\Delta h}{h_0}\right)} \qquad \text{dyne/cm}^2.$$

And as the mean face area of the test-piece during the

initial one minute is $A_0(1 + \Delta h_1/2h_0)$, where Δh_1 denotes the decrease in thickness of the test-piece at the time when $t = 1$ min., we can calculate the mean stress S_m during the initial one minute by

$$S_m = \frac{980W}{A_0(1 + \frac{\Delta h_1}{h_0})} \text{dyne/cm}^2 \qquad (10).$$

The relation between the values of S_m thus calculated and the values of Δh_1 corresponding to the loads employed of the samples N-250 and C-250B are illustrated in Figures 13 and 14. As predicted from equation (9), the relation between S_m and Δh_1 in both cases is linear. Similar results were also obtained in the cases of the other samples used. Since equation (9) holds thus in fact, it is possible to determine β and $\log\psi$ in the already described way. The values of k_0, β and $\log\psi$ thus determined of all the samples used are given in Table 2 together with their values of ASTM penetration. If we plot, using the data in Table II, Δh_1 and $\log\psi$ against ASTM penetration, we obtain the relations shown in Figure 15. As seen from the figure, ASTM penetration has no definite connection with $\log\psi$, although it is almost linearly related with Δh_1. It seems to indicate that ASTM penetration is not an adequate measure for evaluating the firmness of lubricating greases.

Conclusion

The existence of creep phenomenon was ascertained in every sample of lubricating greases used from their flow curves determined by plastometric measurements. It was experimentally shown that syneresis in grease proceeds in direct proportion to creep. The flow property or the firmness of lubricating grease can be approximately expressed by Nutting's empirical formula

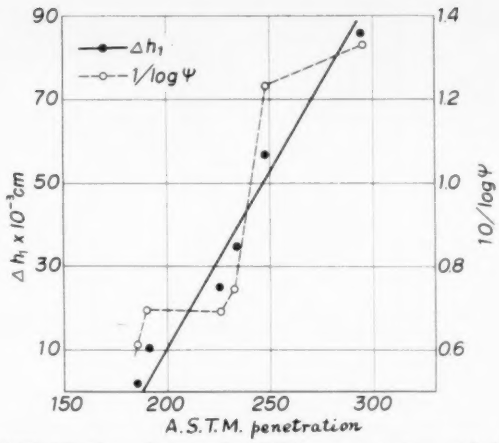


FIGURE 15, the relation of A.S.T.M. penetration with $\log\psi$ and $\triangle h_1$

for the firmness of vico-elastic bodies. The value of Nutting's firmness function ψ has no definite relation with the value of ASTM penetration, it being thereby indicated that the latter seems not to be an adequate measure for the firmness of lubricating greases at least from our theoretical view-point.

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Literature and Patent Abstracts

Tests

On the Mechanism of Gear Lubrication

V. N. Borsoff. J. *Basic Eng.* 81, 79-93, March 1959.

This is a summary of work done for the Department of the Navy during a period from 1953 to 1957. Some of the results or conclusions as they affect gear lubricants will be mentioned.

Five levels of viscosities of mineral oils, silicones, and ucon oils were tested at different speeds and since the curves for mineral oils and for synthetics were similar, it is suggested that all unreactive oils operate through a similar mechanism with the heaviest oil showing the highest load carrying capacity. However, this correlation of viscosity and load carrying capacity cannot be extended to oils of different origin.

The investigation showed that the load carrying capacity of oils decreases with increase of speed in the slow speed range, and increases with speed in the high speed range. With unreactive oils at loads below scoring the mechanism of gear lubrication appears to be thick film lubrication. It is stated that "operation of gears with unreactive oils at loads exceeding their load carrying capacity is impractical. However, the addition of E. P. agents permits the extension of operation to much higher loads than the score load of the base oil."

According to Borsoff, load carrying capacity is not in intrinsic property of the oil alone but is a characteristic of the gear-oil systems. "For example, changes in diametral pitch cause not only changes in the contact ratio, but also in the tooth load and sliding velocity. These changes affect pressure and temperature within the contacting film, thus changing the

viscosity, adsorption, rates of Chemical reaction (with reactive oils), etc."

Consumption

Chassis Grease—Going, Going, Gone?

W. M. Drout, Jr. and N. L. Jenkins, *Petroleum Refiner* 38, 143-46, February 1959.

These authors feel that the automotive grease market is very dynamic and that it reflects both the rapidly changing technology of the automotive industry as well as the changing technology of the lubricating grease industry.

The number of grease fittings on a passenger car are cited to show the decrease from 1950 to the present. Even the continued growth in automobile, truck and bus registrations is not expected to offset the decline in chassis fittings.

It is pointed out that automobile manufacturers are working toward the end that all grease fittings will be eliminated from passenger cars. However, it is also pointed out that if the cost of developing and utilizing the new friction-free or permanently lubricated bearings is high, this might cause a delay or even postpone their use indefinitely.

Also, it is pointed out that the development of lubricating greases with improved properties, such as those which will require longer intervals between applications might check the trend toward elimination of grease fittings on passenger cars.

Composition and Characteristics

Grease Range Boosted is the heading of an article in June 15, 1959 *C & E N*, pages 21 and 22. The description is of a complex calcium base lubricating grease and was given at the 1959 Fifth World Petroleum Congress by Kolfenbach and Morway of Esso Research and Engineering Co.

The complex is made up of calcium acetate and calcium soaps of higher molecular weight fatty acids, the average weight of the combined fatty acids being 77. The complex thickener, which is formed in situ in oil, is said to build into the lubricant extreme pressure and antifretting properties.

The product is said to have an almost flat temperature-consistency curve over a temperature range of 75 to 400°F. Also this lubricating grease resists water, had good worked or shear stability and no abnormal oil separation. As a consequence the product is suggested for multipurpose use and in industrial service for both plain and anti-friction bearings even in such heavy duty service as steel mills. This complex calcium base lubricating grease is now being produced at the rate of over 10 million pounds per year.

Application

Silicone Lubricating Greases

Ragborg and Currie, *Ind. Eng. Chem.* 51, No. 5, May 1959, 49A,

describe some applications where lubricating greases containing silicone fluids have solved difficult lubricating problems.

A combination of a heat-stable silicone and a newly developed high temperature thickener has operated for 500 to 1000 hours in a ball bearing test at 10,000 rpm and 450°F. Non-silicone products fail in about one-tenth of this time.

In a core oven conveyer trolley bearing exposed to 700°F. for two and a half hours out of every four for sixteen hours a day, five days a week, silicone grease has proven satisfactory whereas other products failed.

High Temperature Lubricating Greases

C&EN, 4-13-59, p. 68 report a high-temperature lubricating grease that will lubricate bearings operating between 400 and 700°F. The product consists of a synthetic carrying agent containing an organic thickener and fine-particle graphite and is manufactured by E. F. Houghton and Company.

Oil Daily, 3-27-59, p. 5 and *Petroleum Week*, 4-3-59, P. 42 mention a lubricating grease effective from −65 to 400°F. which is offered by Standard Oil company (Indiana). This product consists of a nonpetroleum lubricating fluid thickened with aryl substituted area.

Composition

Lubricating Greases Thickened with Benzidine Diazo Compounds

Lubricating greases which operate at 400°F. consist of lubricating fluids thickened with pigments of a class of diazotized benzidine derivatives. Such compositions are described by Lyons, Thomas and Odell in U. S. Patent 2,880,177, assigned to The Texas company.

The thickener compounds consist of particles below one micron in diameter and may be employed in pure form or in the form of reduced toners, wherein the compounds are deposited upon particles of inert inorganic materials such as fine silica, aluminum oxide, titanium dioxide, barium sulfate, etc. These

latter materials are generally present up to ten percent of the pigment and may also be accompanied by up to five per cent of metal chlorides, such as zinc chloride, ferric chloride, stannic chloride or cadmium chloride, which enter into the crystal structure during crystallization.

An example of such a product consisted of 20 per cent bis (acetyl-N-o-tolylcarbamylmethyl)4,4′–disazo–3,3′–dichlorodiphenyl, 1 per cent diphenyl-p-phenylenediamine, 3 per cent tricresyl phosphate, 5 per cent mineral oil and 71 per cent synthetic ester. These components were mixed well and milled by two passes through a Premier Colloid Mill.

The product was a smooth yellow lubricating grease with a worked penetration of 311 after 60 strokes and 341 after 100,000 strokes. The dropping point was above 500°F. and in a bearing test at 400°F. failure occurred at 139 hours.

A similar lubricant, in which the fluid was a silicone polymer oil (DC-550), failure occurred after 968 hours.

Roach and Dilworth in U.S. Patent 2,880,176, also assigned to The Texas company, make use of methylchlorophenyl silicone polymer as the lubricating fluid. The specific polymer mentioned is Versilube F-50 sold by General Electric company. This has a viscosity of 180 to 280 seconds Saybolt Universal at 100°F. and contains 5 to 10 per cent by weight of chlorine.

A lubricating grease in which the thickener was the same as mentioned in the previous patent operated 1,843 hours to failure in a high temperature performance test at 400°F. When the temperature was increased to 450°F. failure occurred in 765 hours.

Lithium Base Lubricating Greases Resistant to "Bleeding"

If the soap component of lithium base lubricating greases contains one-half to 20 per cent of either lithium 2-ethyl hexanoate or aluminum 2-ethyl hexanoate the tendency toward oil separation is reduced according to Allison. Such a composition is described in U.S. Patent 2,883,341, assigned to Leffingwell Chemical company.

For example a mixture of 175 pounds of 2-ethyl hexoic acid and 1585 pounds of 60 titer stearic acid were reacted with a water solution of 275 pounds of lithium carbonate, at a temperature of 225°F. to form a mixture of lithium stearate and lithium 2-ethyl hexoic acid soaps. This mixture was separated from the aqueous phase, dried, and blended with mineral oil in the proportion of 20 pounds of the soaps to 80 pounds of oil.

The above product showed an oil separation of 3 to 3 and a half per cent of oil when held in a 60 mesh wire cone for 50 hours at 100°C. Conventional lithium stearate greases were said to separate 6 to 7 per cent of oil under the same conditions. If aluminum 2-ethyl hexonate is substituted for the similar lithium compound the lubricant shows 3 and a half to 4 per cent oil separation in the test above.

Lithium Base Lubricating Greases Containing Excess Lithium Hydroxide

According to Sproule, King and Pattenden (U.S. Patent 2,883,342, assigned to Esso Research and Engineering company) if lubricating greases thickened with lithium soap of 12-hydroxy stearic acid contain 1.0 to 2.0 weight per cent of free lithium hydroxide the spindle life at high temperatures is improved.

Thus in both Table 1 and in the accompanying curve it can be seen that by increasing the excess lithium hydroxide from 0.5 to 1.0 per cent the spindle life at 250°F. is almost doubled. The Table also indicates that the benefit due to excess lithium hydroxide does not hold true if the soap is made from stearic acid.

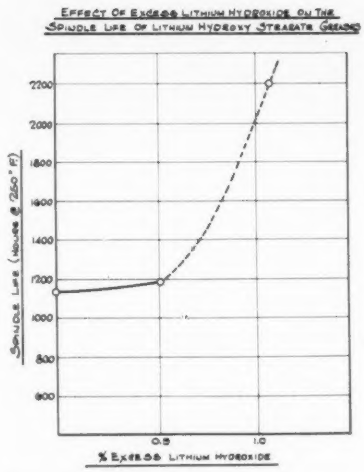

TABLE 1

Grease Designation	A	B	C	D
Formula, % by wt.				
Stearic Acid	—	—	—	12.0
12-Hydroxy Stearic Acid	9.5	9.5	9.5	—
Lithium Hydroxide Monohydrate	1.4	1.9	2.4	3.0
50 V. I. oil vis. 60@210°F.	88.1	87.6	87.1	—
90 V. I. oil vis. 66@210°F.	—	—	—	84.0
Phenyl alpha naphthylamine	1.0	1.0	1.0	1.0
Inspections				
Percent Excess Lithium Hydroxide	Nil	0.52	1.08	1.08
Percent Total Excess Alkali*	0.04	0.60	1.10	1.10
Worked Penetration	244	—	300	270
Spindle Life @ 250°F. hrs.	1,133	1,174	2,200	909

* Combined lithium hydroxide and lithium carbonate.

Thickeners for Lubricating Fluids

Baranauckas and Ashton (U. S. Patent 2,863,906, assigned to Hooker Chemical corporation) describe the production of dichlorotrifluorocrotonic acid and various derivatives of the same. Distillation of amides of this acid with phosphorus pentoxide gave $CF_3CCL:CClCN$. If a solution of this latter compound is mixed with metal carbonates and evaporated a product useful as a grease thickener is stated to be obtained.

According to Finlayson and Jordan (U.S. 2,871,190, assigned to National Lead company), salts of phytic acid having the general formula

$C_6H_6O_{24}P_6Z_{12-n}R_n$, in which Z is a cation, such as H, NH_4, or an alkali metal ion, n is 6 to 12, and R is an organic onium cation containing a hydrocarbon chain of 10 or more carbon atoms, are useful as thickeners for lubricating oils.

Lubricating Greases Having Thickeners Containing Alkyl-Beta-Amino Propionates

Bartlett and Morway in U.S. Patent 2,882,230, assigned to Esso Research and Engineering Co., describe a complex sodium base thickener for lubricating oils which consists of the salt of a low molecular weight acid, such as acetic, the soap of a fatty acid having 10 to 30 carbon atoms per molecule, and the soap of an alkyl-beta-amino propionic acid in which the alkyl group contains 10 to 30 carbon atoms.

For example a lubricating grease was made from:

10.00% by wt. of beta cyanoethyl tallow amine ($C_{18}H_{27}NH\text{-}CH_2\text{-}CH_2CN$)
10.00% by wt. of Hydrofol acids 54
28.50% by wt. of naphthenic lubricating oil of 80 viscosity SUS at 210°F.
4.00% by wt. of glacial acetic acid
6.50% by wt. of sodium hydroxide
40.00% by wt. of naphthenic oil of 40 viscosity SUS at 210°F.
1.00% by wt. of phenyl alpha naphthylamine

The first three ingredients were added and warmed to 150°F. in a fire heated kettle. At this point the acetic acid was added and immediately followed by the sodium hydroxide which had been made into a 40 per cent aqueous solution. Agitation and heating was continued until in 105 minutes a temperature of 520° F. was reached. At this point the heat was shut off and the remainder of the oil was started in. When the temperature had dropped to 275° F. the phenyl alpha naphthylamine was added. Finally, at 200°F. the lubricant was Gaulin homogenized at 3000 psi.

The finished lubricating grease had a free alkalinity as NaOH of 1.02 per cent, an unworked penetration of 200, worked penetration of 241, and after working 100,000 strokes a penetration of 290. The dropping point was 500 F. and a 5 psi drop in a Norma Hoffman test occurred in 165 hours.

Composition and Processing

Clay Bodied Lubricating Greases and Process for Preparation

By subjecting a mixture of certain clays, a lubricating oil, and a dispersing agent to shear while simultaneously vaporizing a portion of the free moisture of the clay thickening of the oil takes place. The clay, which may be Georgia-Florida fuller's earth, sub-bentonite, halloysite or nontronite, should contain not less than 5 per cent and preferably 10 to 30 per cent of free moisture and should have a surface area greater than 50 square meters per gram.

Haden and Martin (U.S. Patent 2,885,360, assigned to Minerals & Chemicals corporation of America) first prepared a grit-free colloidal fuller's earth by dispersing 1,000 grams of a raw Georgia-Florida clay in 2,440 grams of water and permitting the slurry to stand for one hour to settle out impurities. The slurry was then super-centrifuged to remove undispersed clay agglomerates, fine quartz, etc. Finally the slurry was dried at 220°F. to the desired moisture content.

For the preparation of a lubricating grease, 120.5 grams of propane deasphalted oil, having a viscosity of 85 SUS at 210°F. and a V.I. of 80 was agitated with 5.7 grams (4 per cent) of Arquad 2HT. This was followed by 15.0 grams (10.6 per cent) of the colloidal clay and agitation was continued at a rate to generate sufficient heat to vaporize the free moisture in the clay. Agitation was continued until gelling occurred. The product after cooling to 77°F. has an unworked penetration of 249 and a penetration after 60 strokes of 290.

NLGI Associate, Technical

CONTAINER AND CLOSURE MANUFACTURERS

American Can Company
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Representative—H. T. Rich

American Flange & Manufacturing Company, Inc.
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Representative—Richard L. Parish, Jr.

Bennett Industries
Peotone, Illinois
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Central Can Company
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Representative—Henry Frazin

Cleveland Container Company
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Continental Can Company, Inc.
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Rheem Manufacturing Company
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Representative—Hal U. Fisher

Canadian Petrofina Limited
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Montreal, Quebec, Canada
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Cooperative GLF Exchange, Inc.
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Representative—W. S. Miller

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Representative—H. F. Wagner

Illinois Farm Supply Company
100 East Ohio Street, Chicago, Illinois
Representative—S. F. Graham

Ohio Farm Bureau Cooperative Association, Inc.
245 North High Street, Columbus 16, Ohio
Representative—Walter N. Callahan

United Co-Operatives, Inc.
111 Glamorgan, Alliance, Ohio
Representative—G. E. Castree

Valvoline Oil Company
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SUPPLIERS OF EQUIPMENT FOR MANUFACTURING LUBRICATING GREASES

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Girdler Process Equipment Division, Chemetron Corp.
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Renick & Mahoney, Inc.
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Representative—R. Abarno

Stratford Engineering Corporation
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Representative—D. H. Putney

Struthers Wells Corp.
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Representative—K. G. Timm

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American Potash & Chemical Corp.
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Representative—W. F. O'Brien

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Chemical Products Division
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The Baker Castor Oil Company
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Representative—J. W. Hayes

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A subsidiary of National Lead Company
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Houston 2, Texas
Representative—Mr. C. M. Finlayson

Godfrey L. Cabot, Inc.
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Representative—H. P. Donohue, Jr.

Climax Molybdenum Company
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Darling & Company
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Representative—Brian Casey

Foote Mineral Company
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Representative—W. F. Luckenbach

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Representative—W. G. McLeod

Humko—Chemical Department
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Representative—Malcolm M. Moore

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Representative—J. L. Palmer

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Cleveland 15, Ohio
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Representative—T. J. Campbell

Monsanto Chemical Company
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Representative—J. W. Newcombe

Newridge Chemical Company
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Synthetic Products Company
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Representative—Albert E. Miller

Institut Francais du Petrole
CMrR—Courtel, 4 Place Bir Hackeim
Rueil—Malmaison (S. et Oise) France

Laboratoires de Recherches Purfina S.A.
98/100 Chaussee de Vilvorde,
Bruxelles (N.O.H.), Belgium
Representative—R. Gillerot

Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Ave., Chicago 47, Ill
Representative—Mrs. G. A. Krawetz

Industry News

Russian Developments In Lubricants Are Reported

A comprehensive Army study of recent Soviet literature pertaining to developments in the field of lubricants and lubrication to mid-1958 has just been released to industry through the Office of Technical Services, U. S. Department of Commerce.

Also available is a report to the Air Force describing the development of an all-metal concentric cylinder type of thermal conductivity cell for use with natural and synthetic base lubricating fluids. The reports are:

Lubricating Oils and Greases In the Soviet Union. N. Cheremeteff, Engineer Research and Development Laboratories, U. S. Army, May 1958, 114 pages. (Order PB 151294 from OTS, U. S. Department of Commerce, Washington 25, D. C., $2.50.) Recent Soviet developments in the field of lubricants are reviewed in this comprehensive study of the most up-to-date information available. The report is divided into three chapters: Lubricants; silicons and oil additives; and greases. Tables which give the characteristics of the different types of lubricating stuffs are used to supplement the text. Emphasis was placed on oil additives used to counteract wear, oxidation, mechanical deposits, unstability, poor viscosity, and results of temperature variations. The various additives are defined, and their characteristics and functions are given. The Russians, according to the review, are stressing lubricating oils obtained from sulfuric petroleums. This apparently is due to the shifting of petroleum yields from Baku to the Ural and Povolga regions which produce sulfuric oils. In 1960, it is expected that three-fourths of all Russian petroleum products will be derived from these areas. Sixty percent is produced there now. Descriptions of the standard Soviet thermal stabili-

ty test, corrosion test, and detergency test are presented. A table showing the chief characteristics of the internal combustion engines referred to in the text is included.

Thermal Conductivity of Lubricating Oils and Hydraulic Fluids. D. W. McCready, University of Michigan Research Institute for Wright Air Development Center, U. S. Air Force. Mar. 1959. 59 pages. (Order PB 151780 from OTS, U. S. Department of Commerce, Washington 25, D. C., $1.50.) An all-metal concentric cylinder type of thermal conductivity cell was designed, fabricated and calibrated to measure the thermal conductivity of forty natural and synthetic base lubricating fluids. Thermal conductivity values in the temperature range 70 to 500F are reported for fluids considered stable to the higher temperature. Such data are required for engineering designs of heat transfer equipment and were found to be unavailable from literature or other sources. Values are de scribed as precise and for possible correlation can be compared to those of a fluid chosen as a "standard reference." The report includes complete descriptions of the design and operation of the thermal conductivity cell, stability tests used, and thermocouples.

Battenfeld Invites Inquiries

Battenfeld of New York advises their automatic filling and sealing equipment is now in full operation to properly handle the polyethylene tube, for oil or grease packaging.

Noting that lithographed polyethylene tubes are finding more and more acceptance in the field, Battenfeld of New York invites inquiries about dispensing packages. Interested parties should write or send designs and artwork to Battenfeld Grease and Oil Corporation of New York, North Tonawanda, N. Y.

American Cynamid Selects New Site

American Cyanamid company has selected a 180-acre tract in rural Wayne township, Passaic County, N. J., as the site of its new administrative offices.

Construction is expected to start this fall, according to Dr. W. G. Malcolm, Cyanamid president. The new buildings have been planned in units which will be completed and occupied at intervals over a period of years and may eventually house a staff of some 1,500 employees.

Preliminary plans call for a campus-like arrangement of buildings with no structure exceeding three stories in height.

Cato Oil and Grease Co. Suffers Million Dollar Fire

A four-alarm blaze struck Cato Oil and Grease company, a Kerr-McGee owned subsidiary in Oklahoma City, on the night of August 24.

Estimates of the damage top the $1 million mark. The Cato fire—Oklahoma City's worst in recent years—was discovered and reported by nightwatchman H. B. Rogers on his rounds of the plant at 10:30 p.m.

An estimated 225 firemen manning at least twenty pieces of heavy equipment fought the fire that raged until 4:30 a.m. the next morning, after which time they worked for several hours dousing scattered pockets of smoldering embers.

A thirteen-year-old boy, who recently had been released from a hospital after undergoing mental observation, admitted setting the blaze.

SHOWN in these two photographs is part of the devastation wreaked by a million dollar fire which swept the Cato Grease & Oil Co. plant last August 24. In the photo at the top smoke still rises from smoldering embers some twelve hours after the fire started. In the photo below a mountain of burnt tin is formed from containers of various sizes meant to carry products to market.

When asked why he set the fire, he retorted, "I set the fire because I didn't like the people. I didn't like their attitudes. They threw things around."

Kerr-McGee made Cato a subsidiary of the company by buying out all of its capital stock in 1957. By-word of Cato since it was founded 37 years ago, has been, "If it's made from oil, Cato can make it."

Prior to the fire Cato produced over 500 products including lubricating grease, automatic transmission fluid, tool-joint and pipe-thread compounds, flyspray, hydraulic brake fluid, permanent anti-freeze, cutting oils, roof coatings, wood

preservatives, window and glass cleaner, outboard motor oil, deodorants, fingernail polish and many others.

Rebuilding plans call for a new more modern up-to-date plant to rise from the ashes at the Cato Oil and Grease Company, it was announced by Claude Huffman, Cato president. In the meantime, adequate production facilities have been set up to serve their customers and Cato is still very much in business.

Temporary offices have been set up adjoining the plant. The phone number and address of Cato are still the same as before the fire. CE. 2-6115 and 1808 N. Ninth St., Oklahoma City 13, Oklahoma.

Petroleum Packaging Committee Meeting

A meeting of the Petroleum Packaging committee will be held at the Goodhue hotel in Port Arthur, Texas, on October 12 and 13, 1959. It is estimated that approximately 100 people will attend, representing approximately 50 petroleum and chemical companies throughout the United States and Canada.

This is the tenth year of the Petroleum Packaging committee's activity, and the history of this group has been published by the Packaging Institute, Inc. This history well outlines the work which has been done in standardization of containers and packages for the petroleum industry.

The work of the Petroleum Packaging committee is endorsed not only by the Packaging Institute, but also the American Petroleum Institute-Lubrication committee, and the National Lubricating Grease Institute.

Committees are appointed to thoroughly investigate each problem, making progress reports to the entire Petroleum Packaging committee, and to complete, draft and publish these recommendations or specifications which are made a part of the Petroleum Packaging committee *Notebook of Specifications.*

The Petroleum Packaging committee meets three times a year in various parts of the country.

A tour of the Gulf Oil corporation and Magnolia Petroleum company plants is scheduled for October 13.

Comparison of National Surveys by API

A comparison of national surveys of motorists' buying habits conducted in the years 1955 and 1957 shows that car mileage between oil changes rose more than 325 miles over the two-year period, the American Petroleum Institute disclosed in a report issued last month.

The survey results "give additional evidence to bear out the continually declining trend of the overall motor oil-to-gasoline ratio which has been evident over the past several years," the report states.

The weighted average distance traveled between oil changes rose from 1,599 miles in 1955 to 1,925 in 1957—an increase of 326 miles. This represents 20 per cent fewer oil changes in 1957 than in 1955 and, projected nationally, approximately 53.75 million less gallons of oil sold in 1957 than in 1955 in crankcase oil changes.

The median (exact mid-point in all figures collected) in the number of miles between oil changes increased from 1,348 to 1,788—a rise of 440 miles or 33 per cent.

The findings are based on answers to a series of questions prepared by the Marketing Research Committee of the API's Marketing Division, which were included in the 1955 and 1957 automotive surveys conducted by Crowell-Collier Publishing Co and *Look* magazine. More than 9,000 motorists throughout the nation were interviewed in the two surveys.

Since they were tabulated at different times and on separate bases, the special questions on oil changes and lubrication had to be retabulated to allow comparison.

Service stations generally reflected a gain in favor in 1957 over 1955 as the place where consumers took their cars for oil changes and lubrication, the API report showed. Motorists displayed less inclination for

"do-it-yourself" oil changes, and such sales dropped about five per cent.

By geographic regions, service stations showed a decline in 1957 from 1955 in lubrication work done in total South, South Atlantic, and South Central states. Independent garages registered gains in these areas during the two-year period.

The detailed report (API Publication 1534) may be obtained at 50 cents a copy from the Division of Marketing, American Petroleum Institute, 50 West 50th Street, New York 20, N. Y.

New System for Lincoln

A new miniaturized injector system for automatic lubrication of production machinery has been introduced by Lincoln Engineering company, division of the McNeil Machine & Engineering company, St. Louis. Called the micro-measure system, it pre-measures and injects fluid lubricants to "millionths of an ounce" in automatic cycles as often as every minute.

An automatically controlled, air-operated pump supplies refinery-pure lubricant to small, economical injectors with micro-meter adjustment—at a predetermined rate, in quantities as small as 1/135 of a drop (200 millionths of an ounce). The system is said to maintain a constant, uniform oil film on all bearing surfaces with no overflow and no dripping. It has been successfully applied in the textile processing, metalworking, packaging and other industries, at "very low cost."

People in the Industry

Hansen Succeeds Fowler

C. S. Hansen has been appointed head of the Pure Oil company's industrial sales service department, succeeding W. H. Fowler, Jr. who retired September 30.

Mr. Hansen who joined Pure in 1950, has served in executive positions in both the retail and wholesale marketing divisions. Mr. Fowler, an authority on lubrication engineering, had been associated with the company for 29 years.

Joseph Dixon Crucible Co. Elects Two Vice-Presidents

The election of two vice-presidents of the Joseph Dixon Crucible company, Jersey City, N. J., was anounced by Frank G. Atkinson, president.

David C. McMillin, pencil division sales manager, was elected marketing vice-president of the company's pencil division and of the company's subsidiary, the American Crayon company, Sandusky, Ohio.

R. C. Brock, industrial division manager, was elected vice-president in charge of the parent company's industrial division.

In his new capacity, Mr. McMillin will direct the sales and marketing activities of all writing commodities manufactured by both the parent and subsidiary company. The Joseph Dixon Crucible company manufactures the Ticonderoga pencil and other writing instruments, and the American Crayon company manufactures chalks, artists' paints and educational art materials.

Mr. Brock will supervise sales and marketing activities of Dixon's industrial division, which manufactures such products as crucibles, refractories, industrial lubricants, protective paints and other products with graphite ingredients.

Brock, born in the midwest, joined the Dixon organization in 1948 as a salesman in the industrial division, covering the northern California territory. Within two years he was appointed district manager of an area embracing eleven states, and in January, 1955, he was promoted to the post of industrial sales manager and summoned to headquarters in Jersey City to take over that post.

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He was a staff sergeant in Army counter-intelligence during World War II, served in New Guinea, the Philippines and Japan, and his decorations include the Bronze Star. He now lives with his family in Madison, N. J.

Nelson Manager for ADM

George K. Nelson, director of development for Archer-Daniels-Midland company the past four years, has been named manager of the company's chemical products division, it was announced by W. G. Andrews, executive vice-president-chemical group.

Nelson succeeds Burton W. Schroeder, recently elected administrative vice-president of ADM.

Instrumental in organizing ADM's development department, Nelson previously was assistant manager of the Celanese corporation's chemical product development department. Prior to that he did product development work for Shell Development company.

Nelson is a graduate of Coe college. He received his master's degree in chemistry, and doctorate in physical chemical from Purdue university. He is a director of Applied Radiation corporation, an ADM affiliate, and a member of the American Chemical Society and Commercial Chemical Development association.

ADM operates chemical plants at Wyandotte, Michigan, and Ashtabula, Ohio. It is a leading producer of fatty acids, fatty alcohols, hydrogenated glycerides, sperm and marine oils, olefins, saturated hydrocarbons and fatty nitrogen chemicals.

E. A. Hugill, Jr., Is Secretary for Shell

E. A. Hugill, Jr. has been elected secretary of Shell Oil company.

Mr. Hugill was also appointed secretary of Shell Chemical corporation, International Lubricant corporation, and Shell Canadian Exploration company. He succeeds J. A. Horner as secretary of those companies. Mr. Hugill was also appointed a vice president of Shell Development company and will succeed Mr. Horner as vice president in charge of the licensing division later in the year.

Mr. Horner is taking up a position with Shell Pipe Line corporation on about November 1, 1959, and has been nominated to succeed Joe T. Dickerson as president of that company, when Mr. Dickerson retires on December 31, 1959.

Mr. Hugill, who received his AB and LLB degrees from the University of California, joined Shell in 1933 as a law clerk in the San Francisco office. He became an attorney there in 1936 and, after serving at various locations, was appointed general attorney of the company in the New York legal department in July 1954.